

Assessment of Greenland turbot (*Reinhardtius hippoglossoides*) in the Bering Sea and Aleutian Islands

Authors: Steve Barbeaux, Jim Ianelli,
Dan Nichol and Jerry Hoff



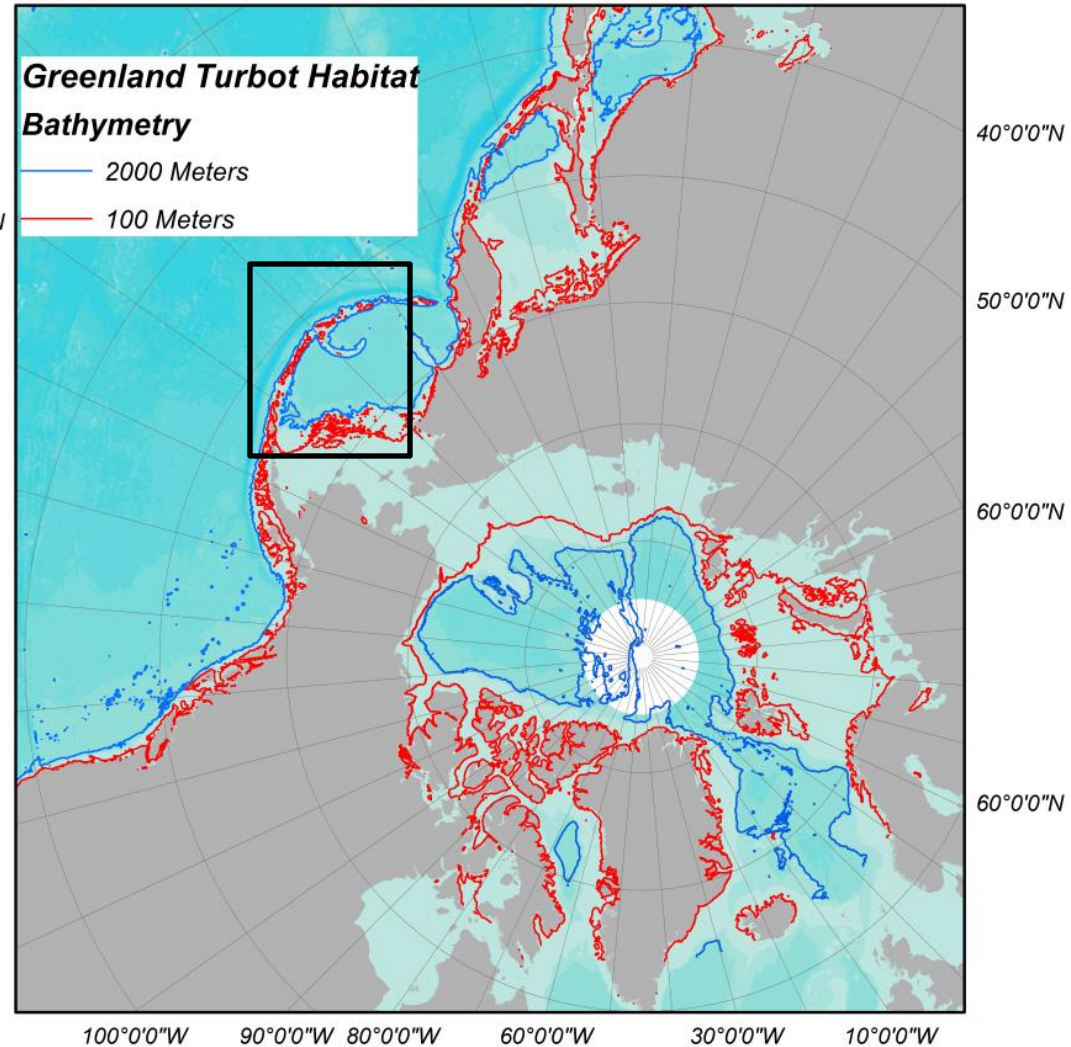
Presentation to the North Pacific Fisheries Management Council's
Bering Sea and Aleutian Islands Plan Team

November 17, 2014

Pan-polar Distribution



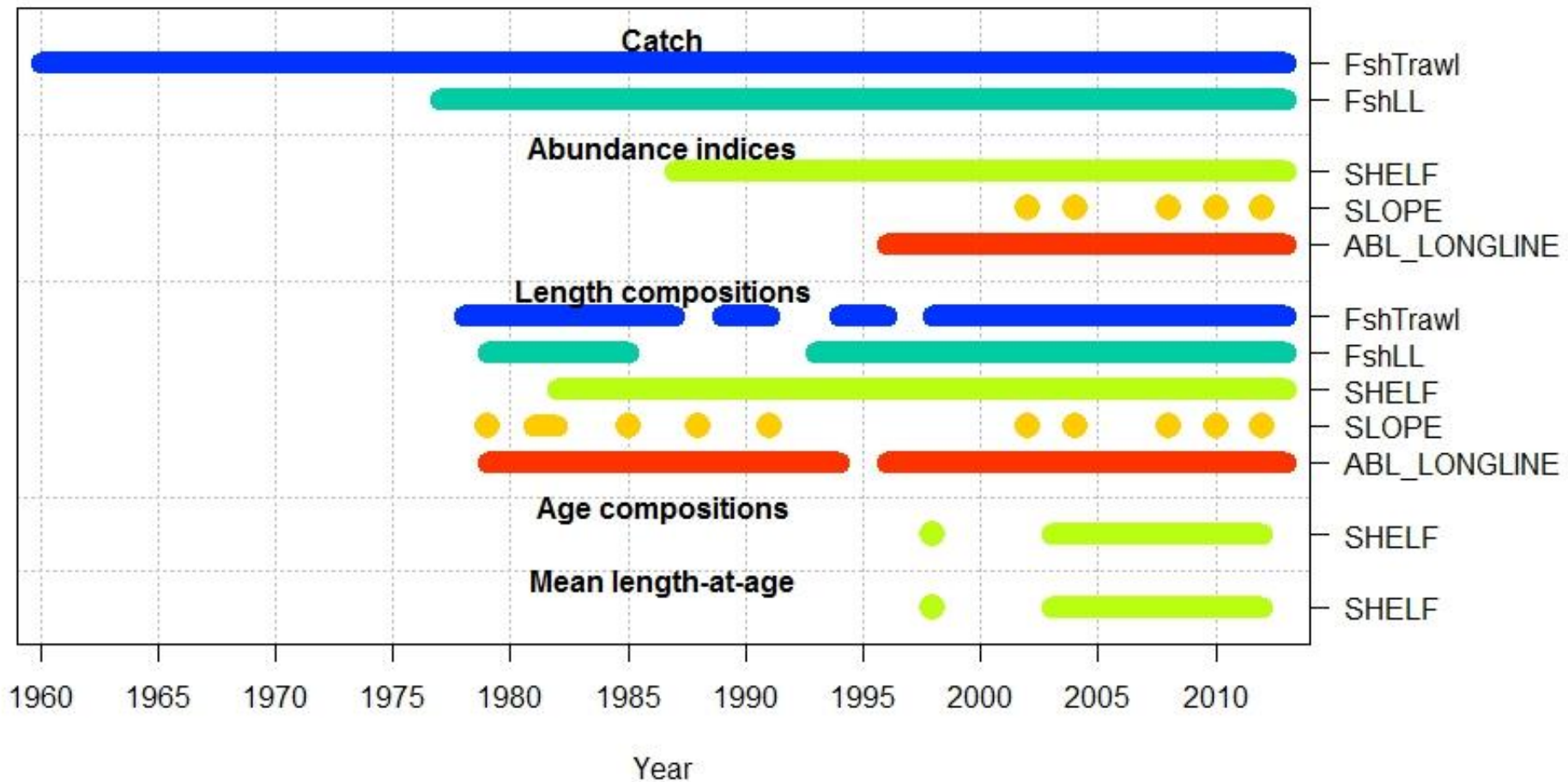
- Same species as the Atlantic
 - Greenland halibut
- Between 100 and 2,000 m
- BSAI population straddles the US-Russian EEZ



Data sources - 2013



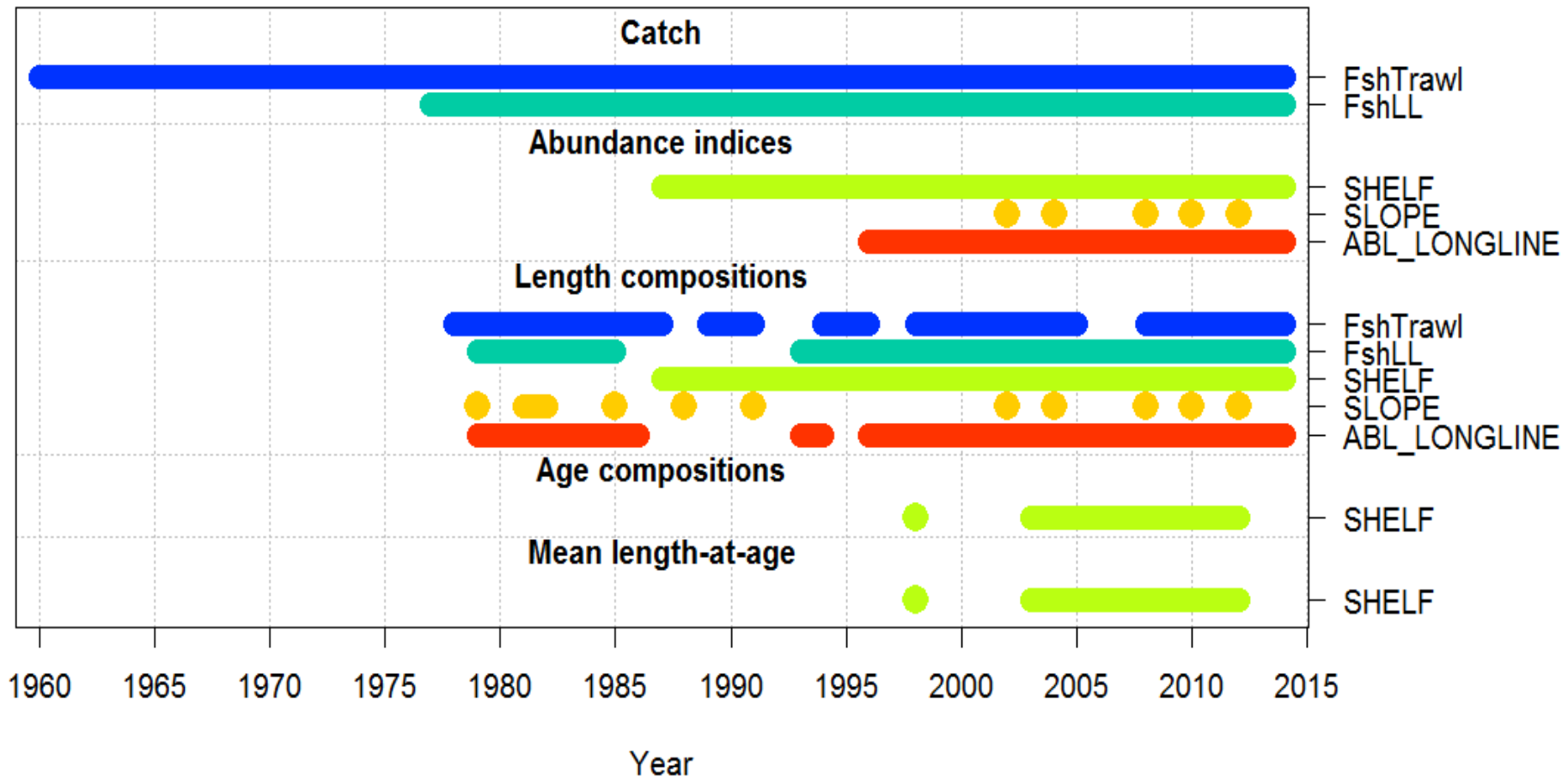
Data by type and year



Data sources - 2014



Data by type and year

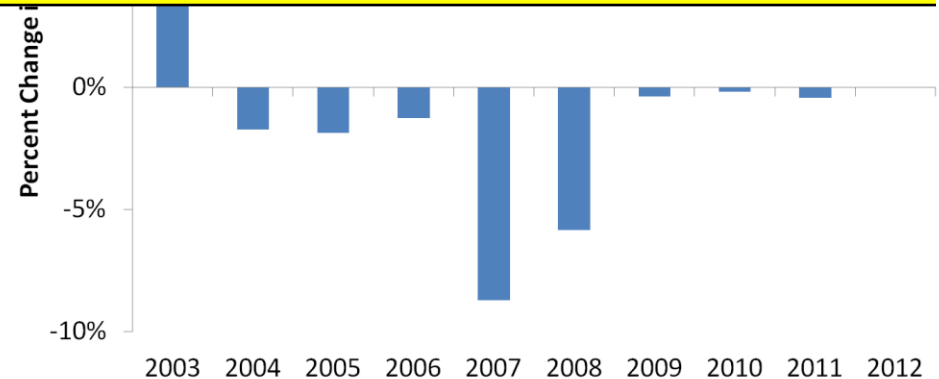
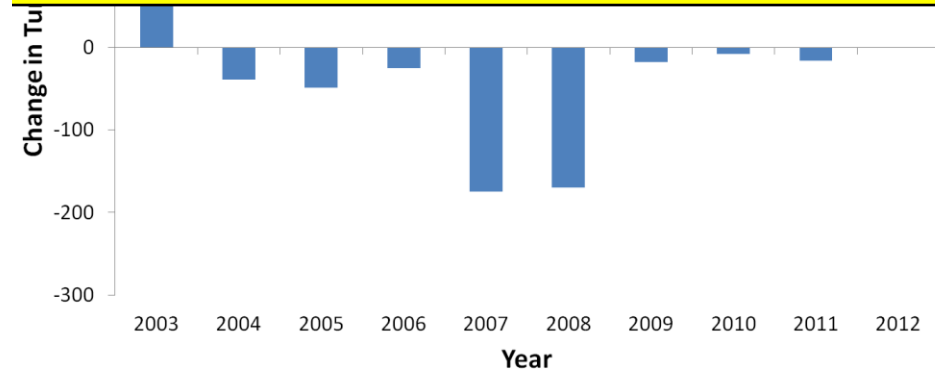


Change in Total Catch Data

- Largest changes in 2003, 2007, and 2008

Difference from 2013

Area	Gear	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Aleutian Islands	Fixed	290	-20	-29	-12	-7	1	-2	-7	-1	-1
	Trawl	-25	0	0	0	0	0	0	0	0	0
AI Total		265	-20	-29	-12	-7	2	-2	-6	-1	-1
EBS	Fixed	97	-20	-20	-11	-140	-173	-15	-1	-15	0
	Trawl	-16	0	0	-2	-29	0	0	0	0	0
EBS Total		81	-20	-20	-13	-168	-172	-15	-1	-15	1
Grand Total		346	-39	-49	-25	-175	-170	-18	-8	-16	0

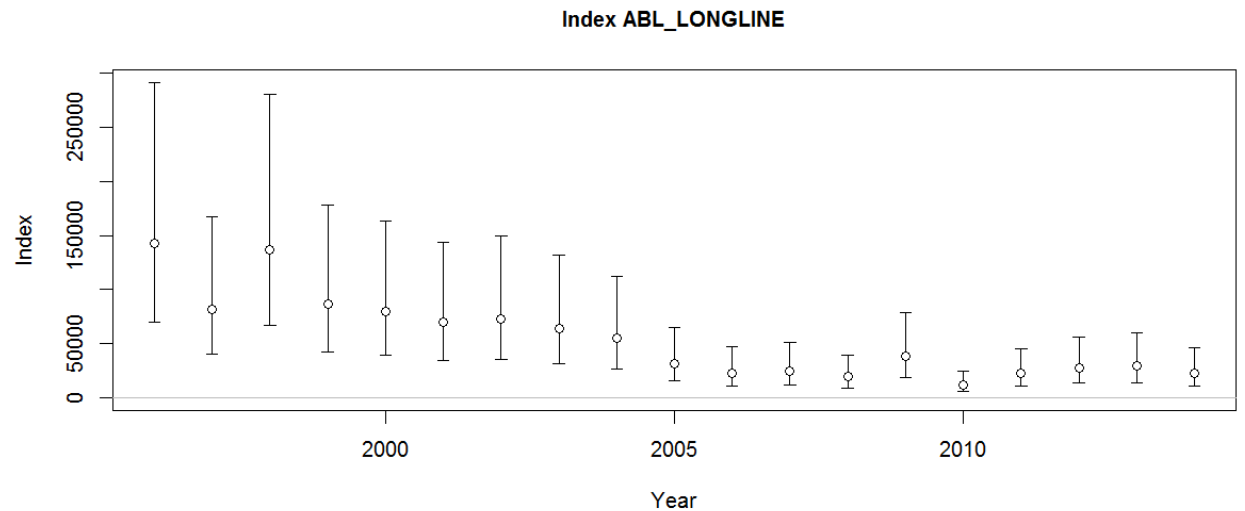
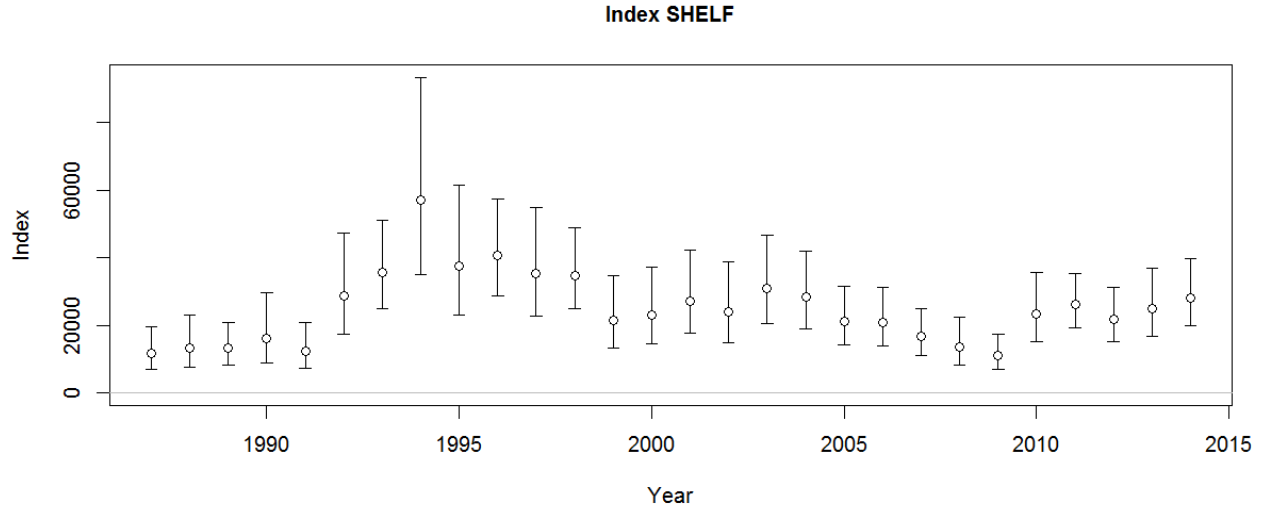


New surveys

- 2014 Shelf survey, (28 KT) nearly the same as 2010-2012 estimates (22 -26KT)

- `

- ABL longline survey down slightly, 23 k from 29 k



AFSC Surveys

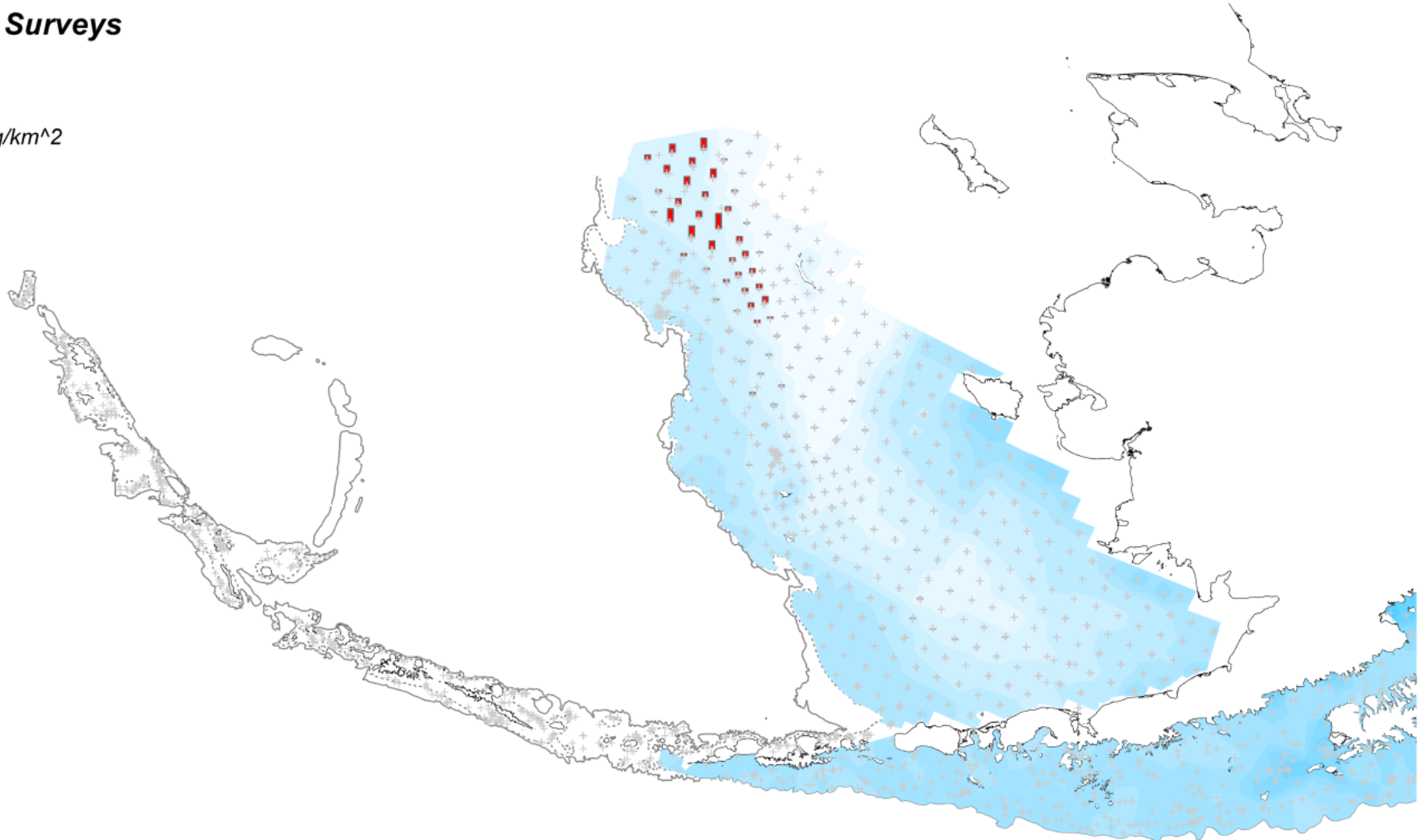


2013 AFSC Surveys



3,700

CPUE kg/km²



AFSC Surveys



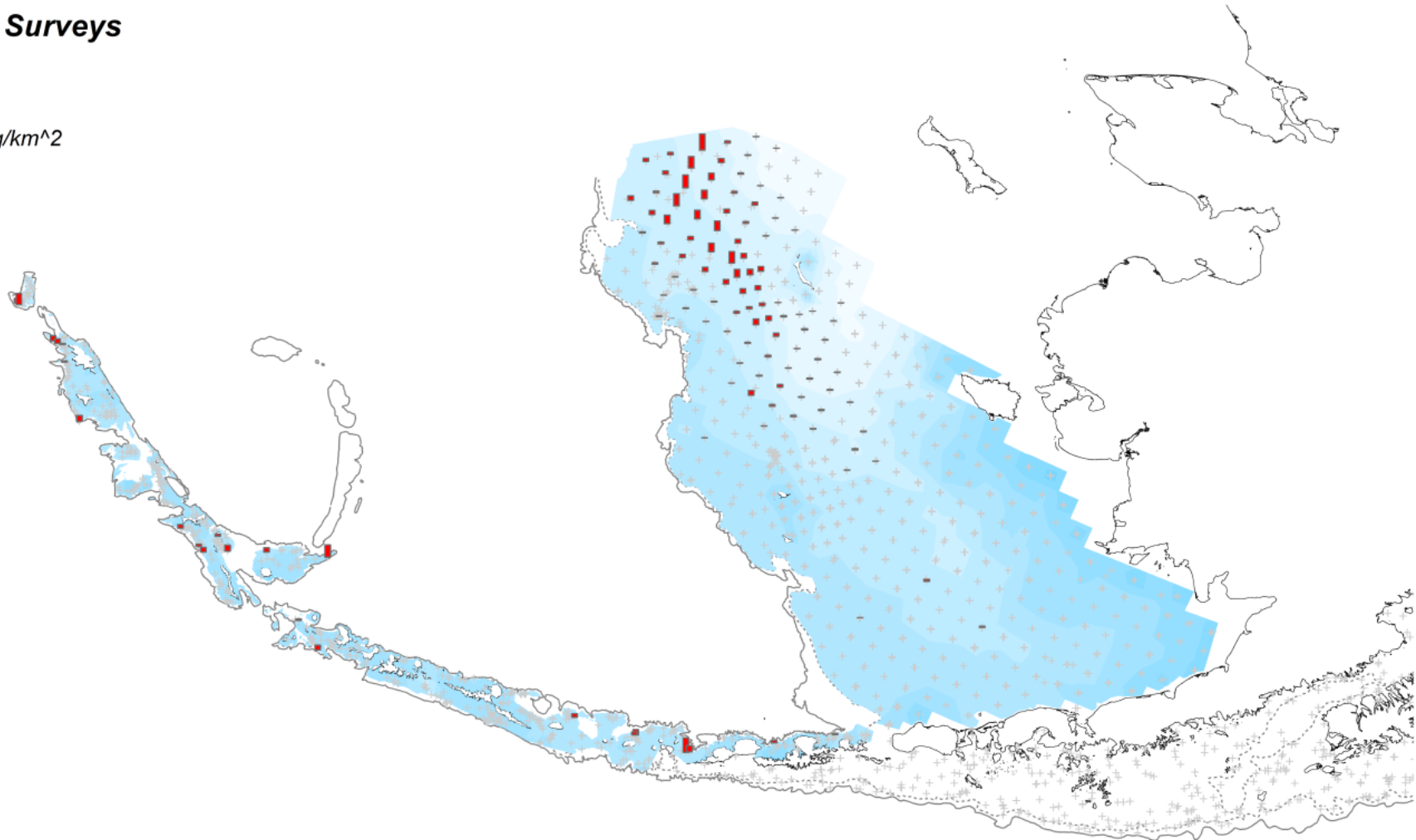
2014 AFSC Surveys



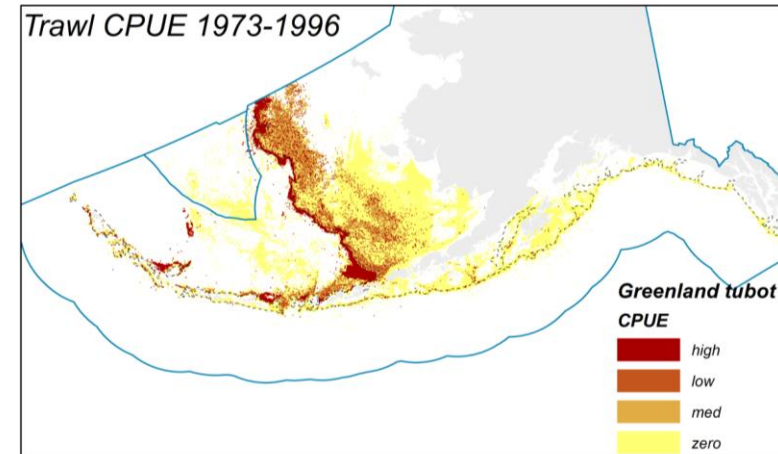
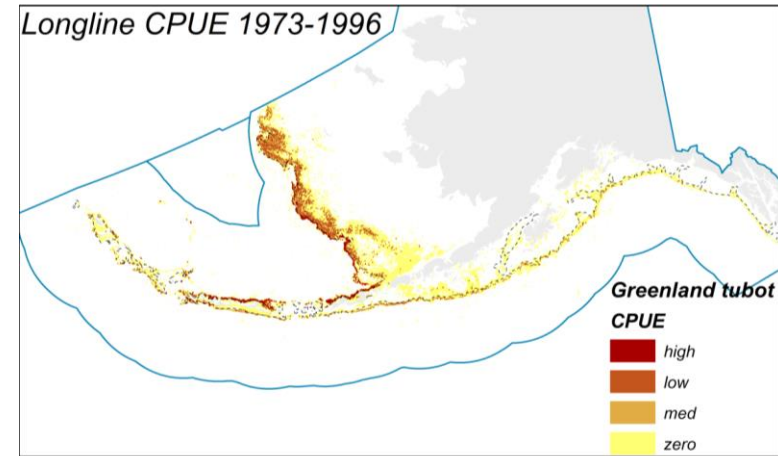
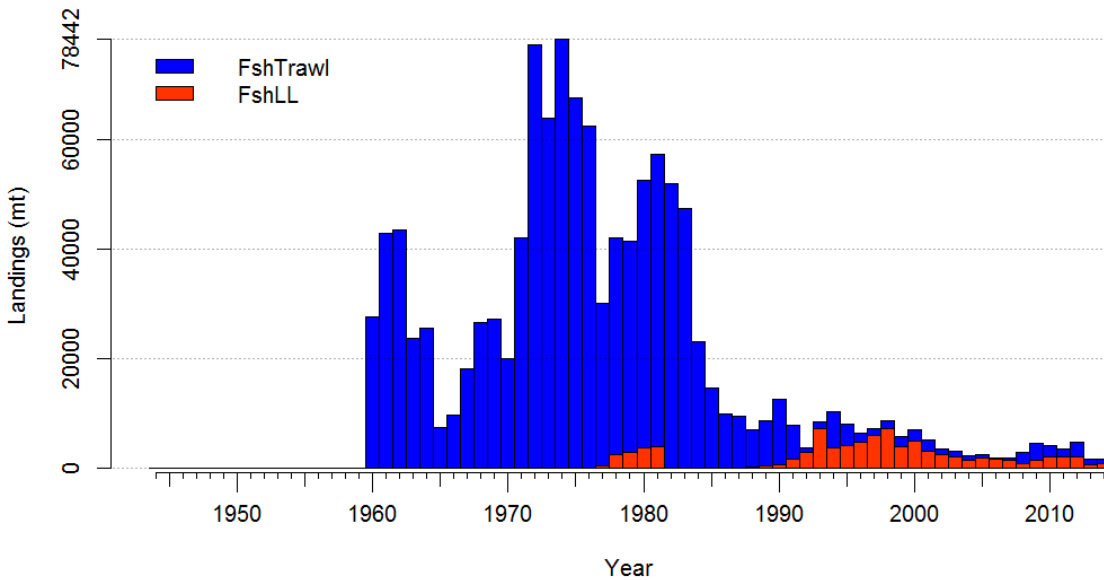
3,700



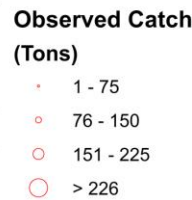
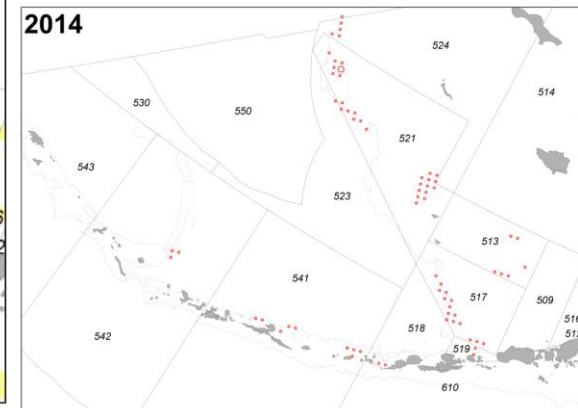
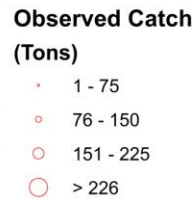
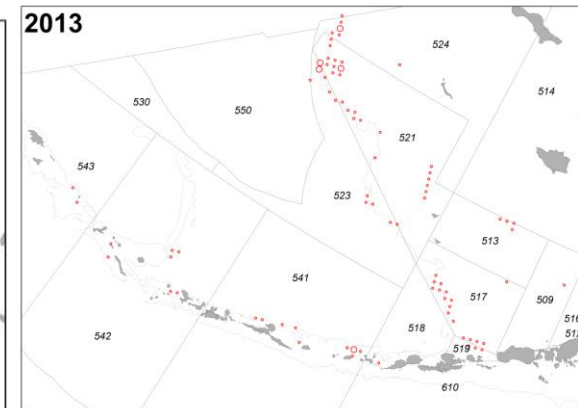
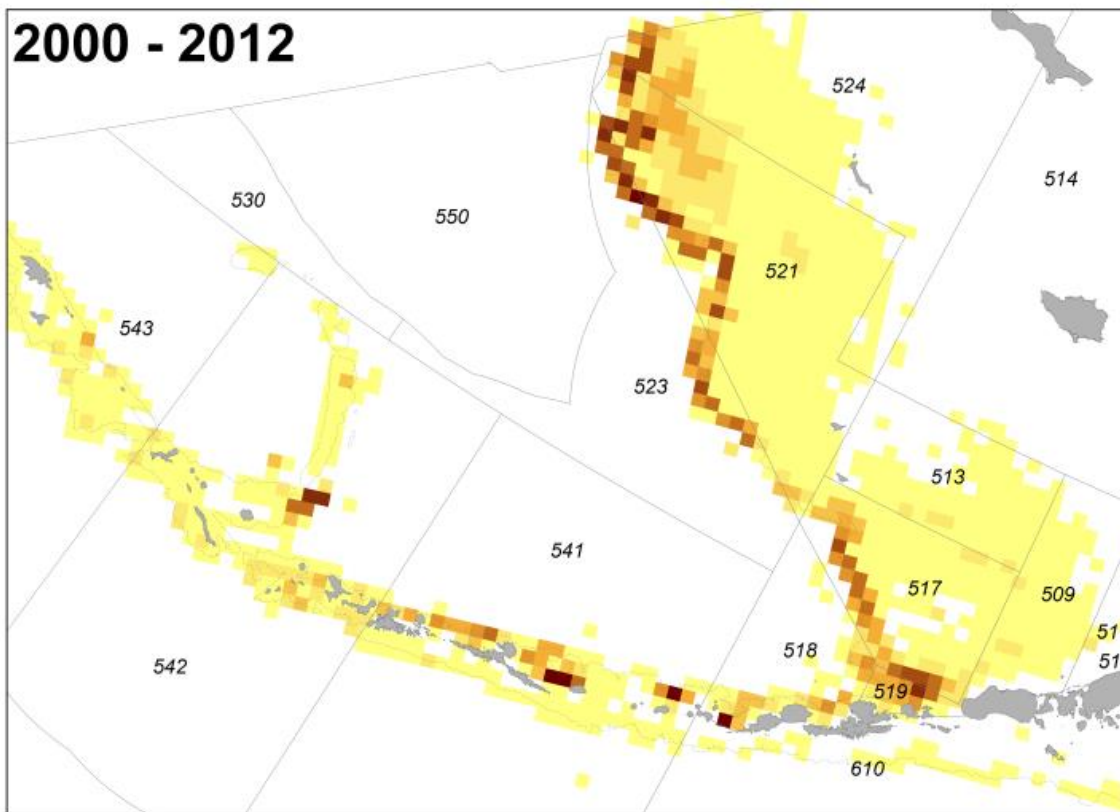
CPUE kg/km²



Greenland turbot catch



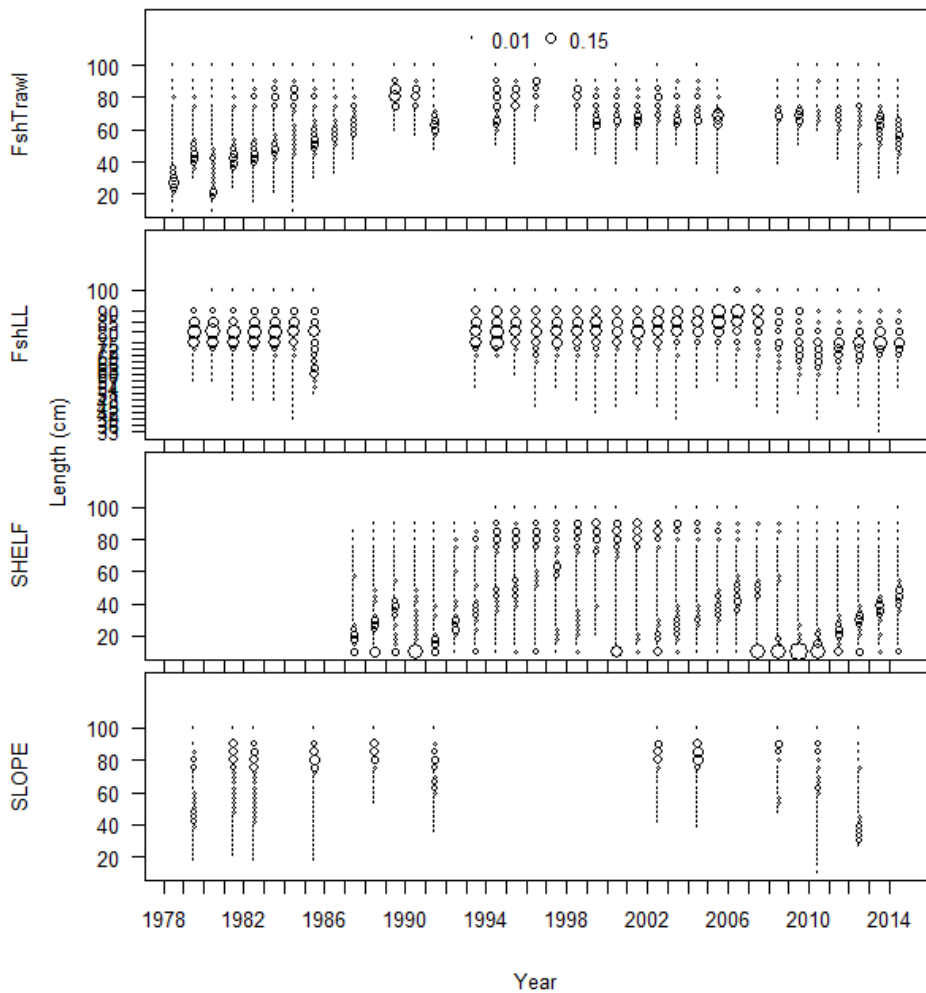
Greenland turbot catch



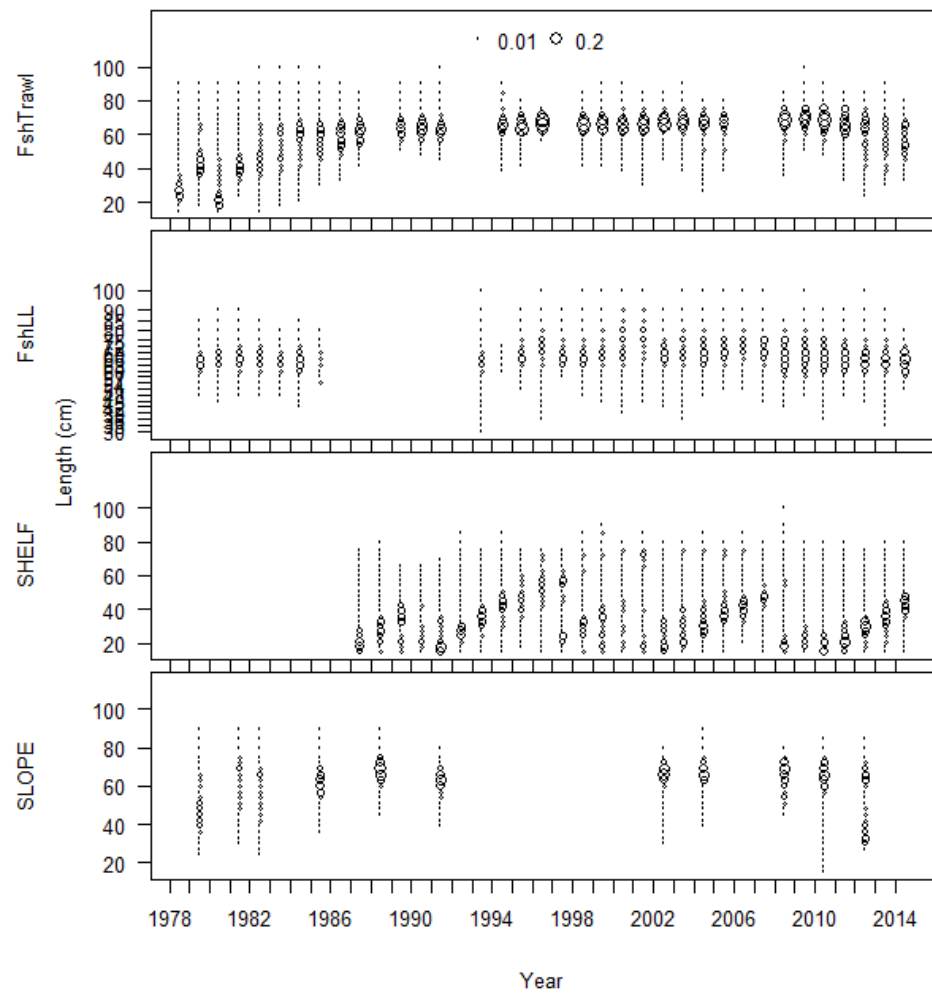
Size composition



Female



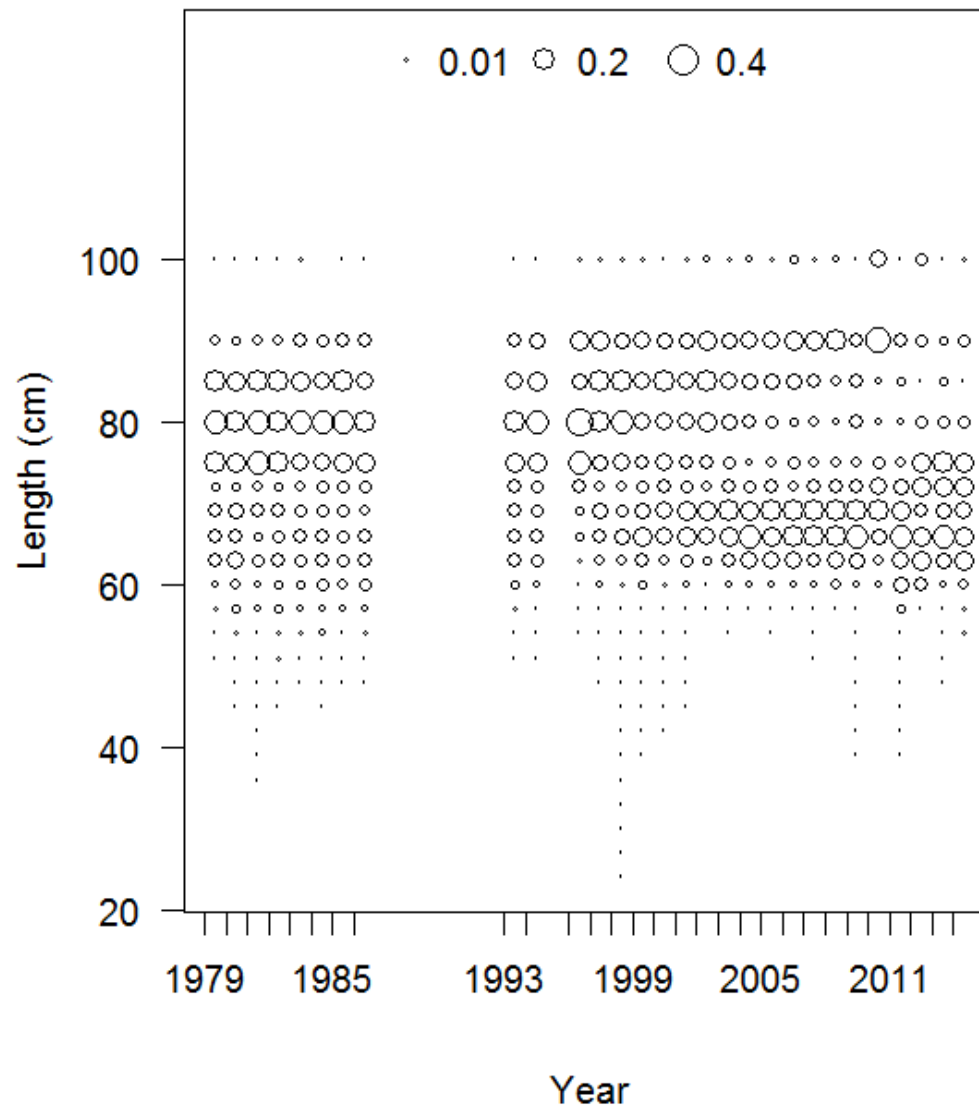
Male



Size composition - Combined



ABL longline Survey



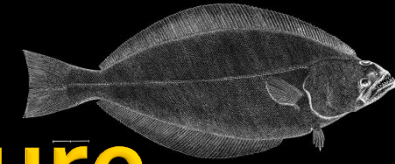
2014 Models



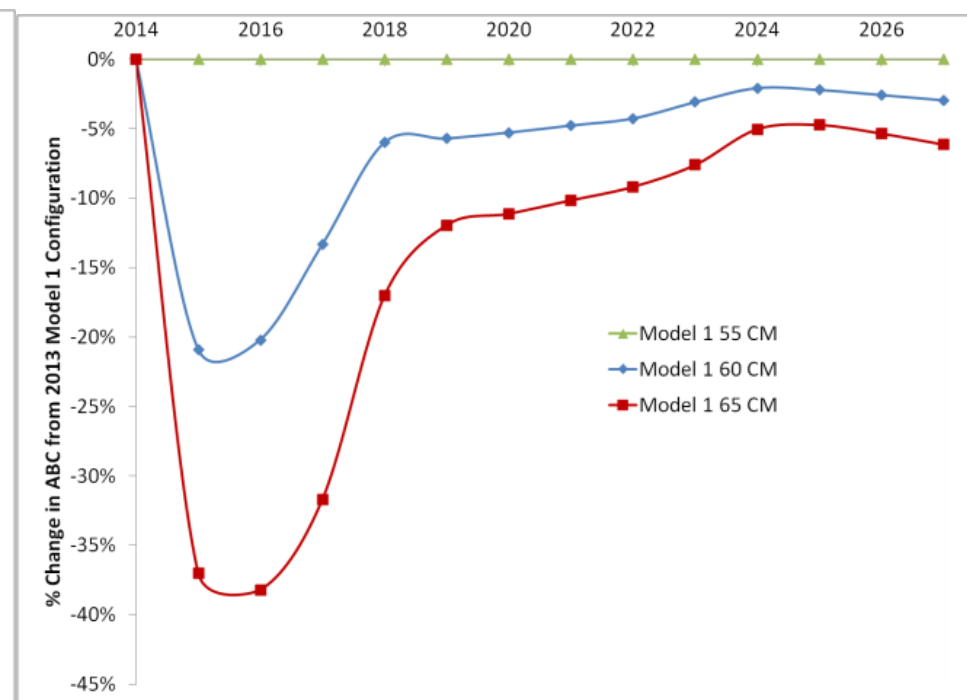
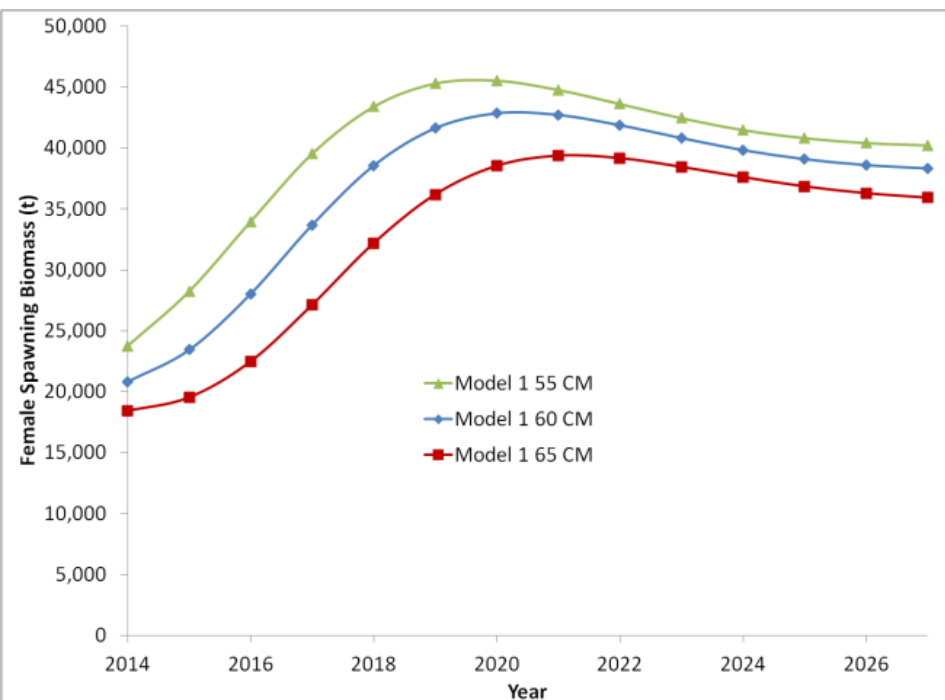
- Model 1
 - 2013 Preferred Model with 2014 data
 - Updated catch, large change in 2003, 2007, and 2008
 - Northwest area length composition (1982-1987 not used)
 - Female length at 50% mature at 60cm

- Model 2
 - Same as Model 1 except:
 - RecDev autocorrelation
 - Thorson et al. (2014) prior on $\text{Rho} = 0.473$, $\text{SD} = 0.265$
 - Fixed catchability for slope and shelf surveys
 - Shelf = 0.62 , Slope = 0.57

Female Length at 50% Mature



- D'yakov (1982) = 60cm
- Cooper et al. (2007) = ~65 cm

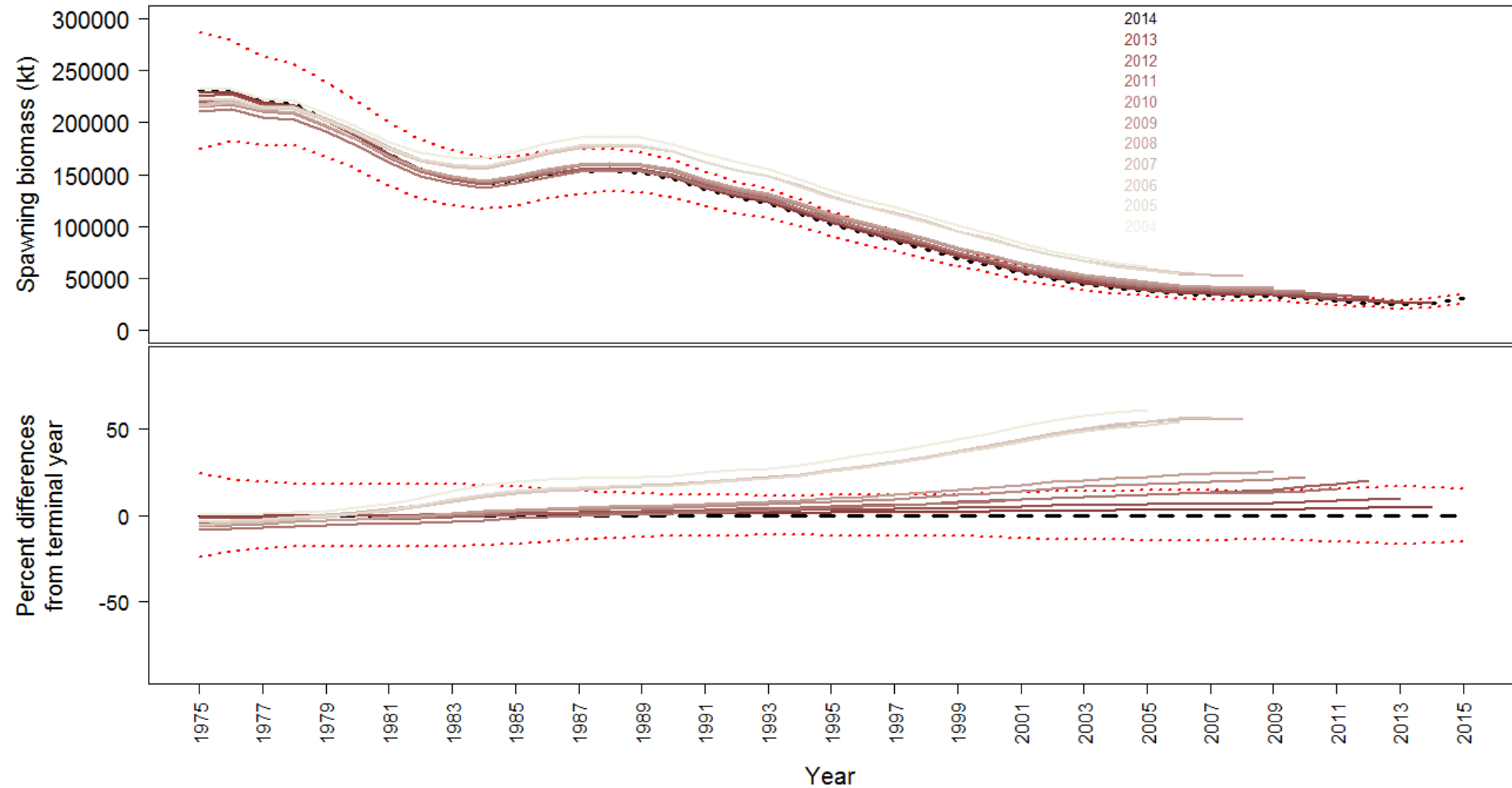


2014 Model selection



	2013	Model 1	Model 2
Number of Parameters	130	130	135
Likelihoods			
Total	2428.7	2156.78	2015.07
Survey	-30.1	-44.52	-36.87
Length Composition	1181.8	993.60	887.18
Age Composition	140.8	72.85	71.08
Size at Age	1015.2	1016.82	1023.58
Recruitment	118.7	115.40	66.00
Parameter priors	2.2	2.45	3.96

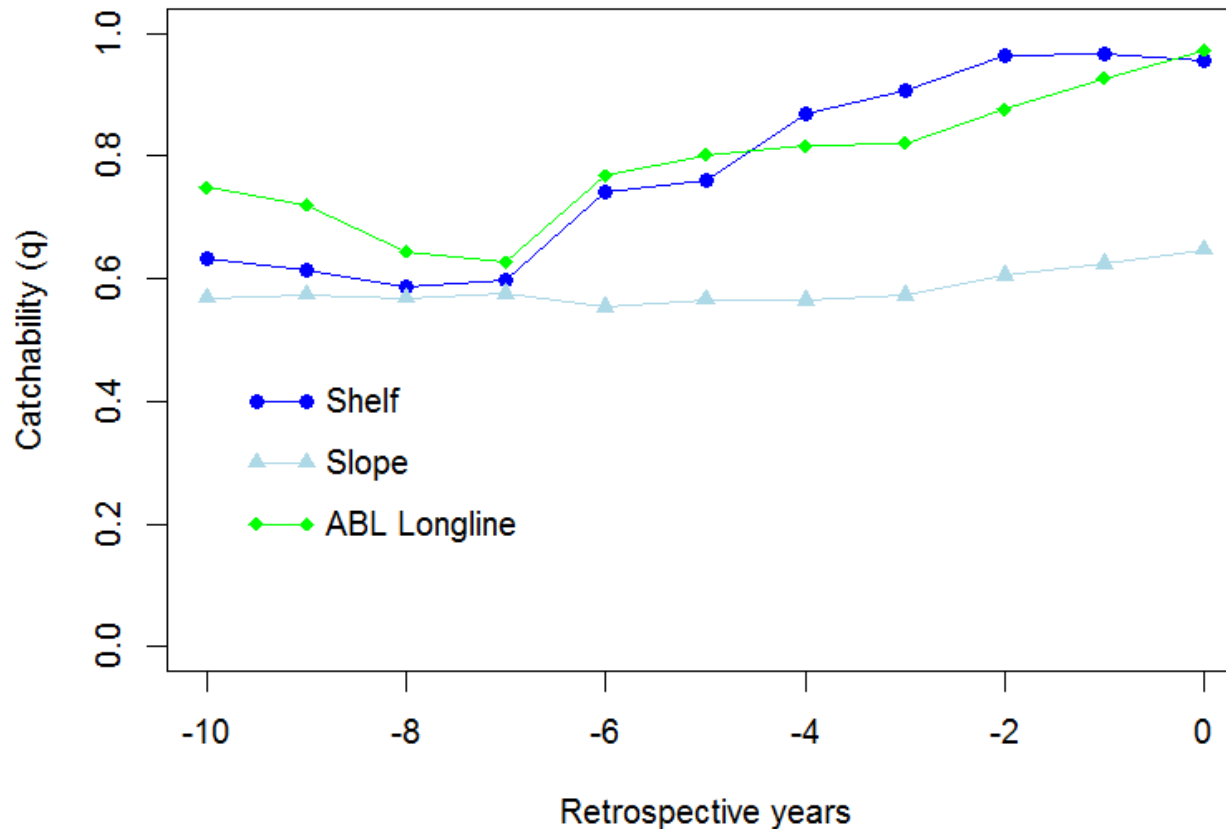
2014 Models - Retrospectives



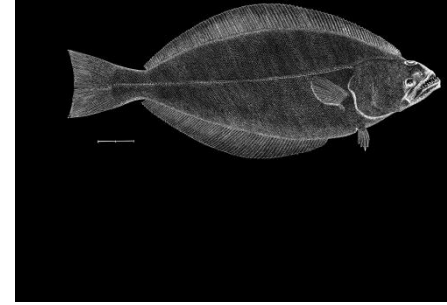
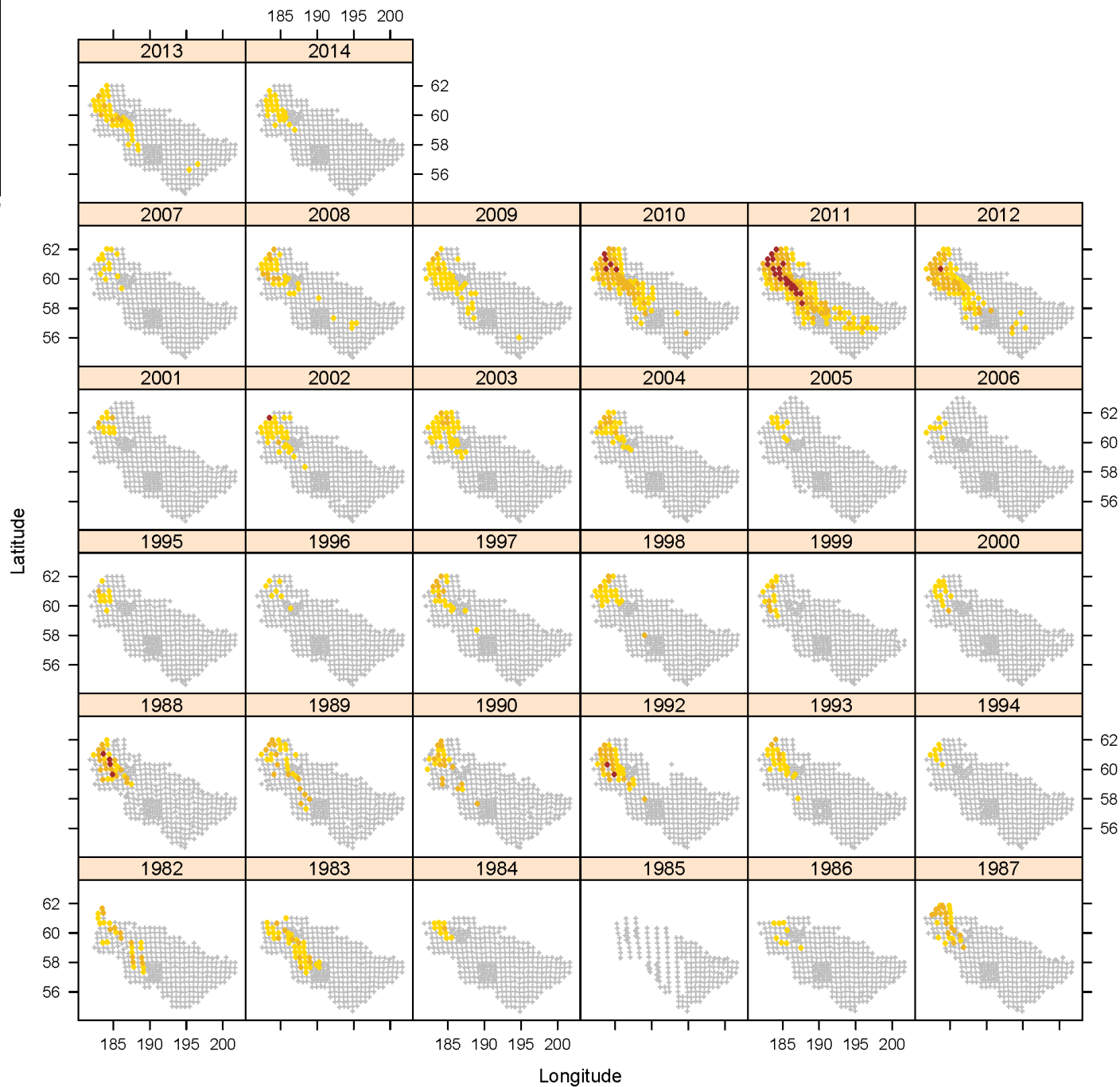
2014 Models - Catchability



- Shelf Catchability highly unstable in the retrospective prior to 2008



Greenland turbot between 200 and 300 mm

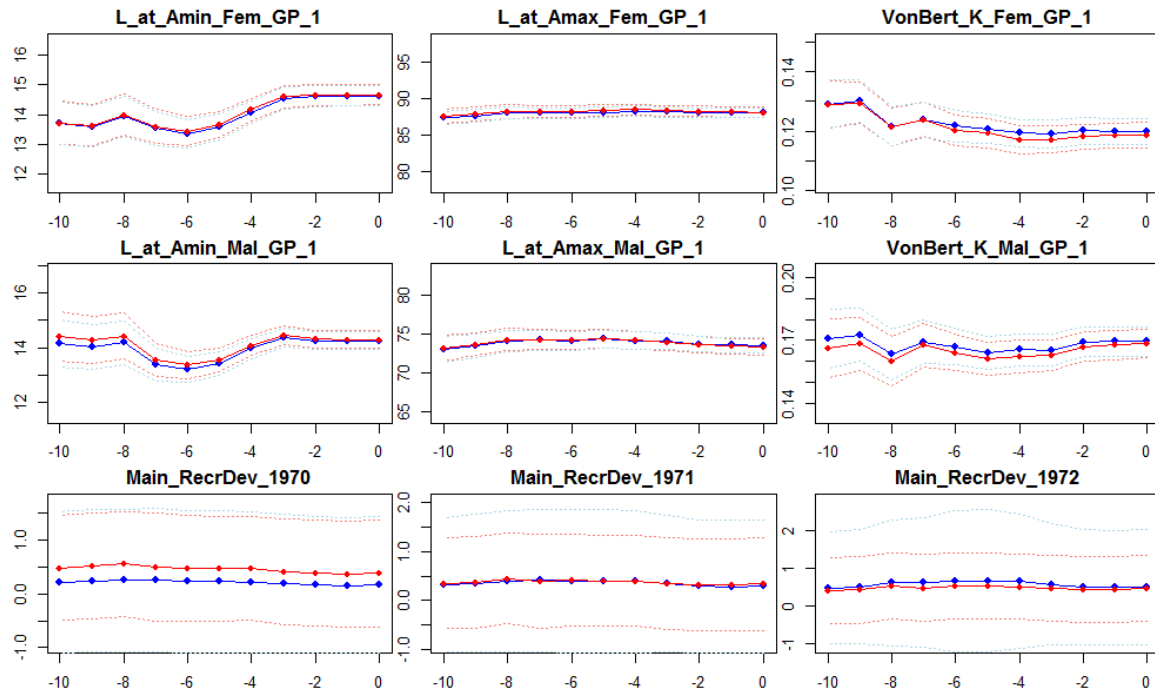
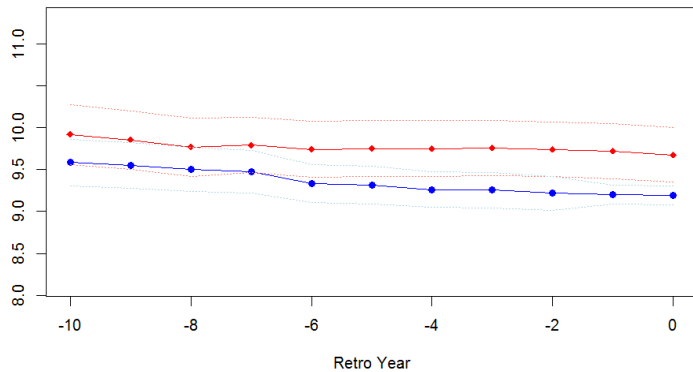


2014 Models - parameters

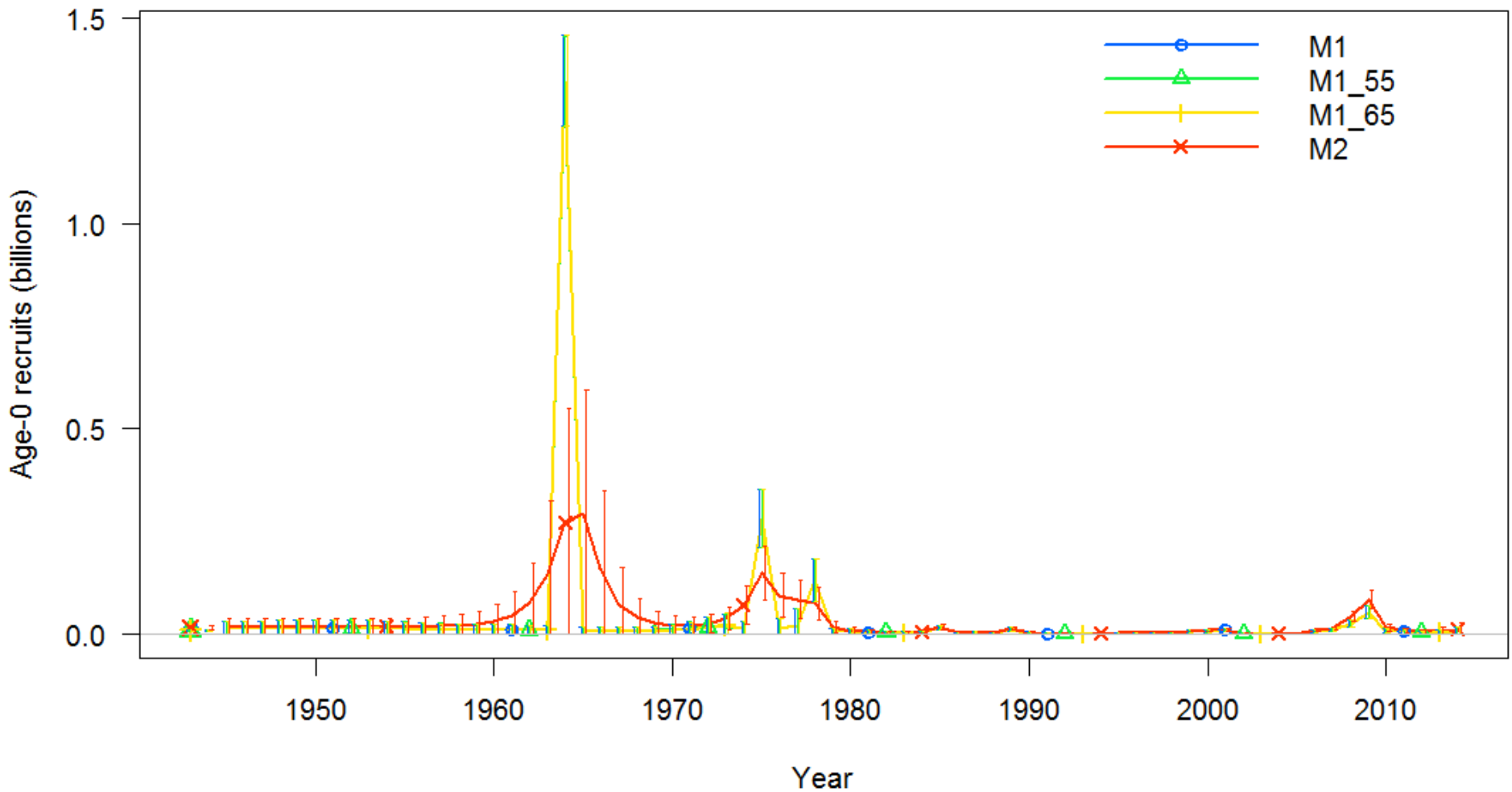


- Retrospective pattern in other parameters
 - Changes after the 2008-2009 year classes arrive in both models.

SR_LN(R0)



Model comparison - recruits

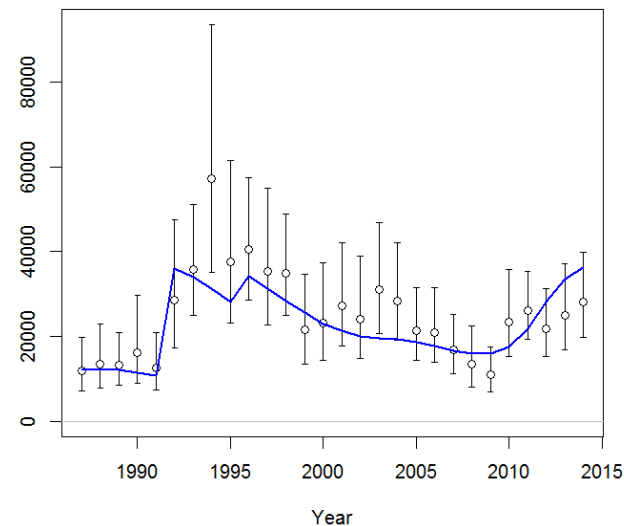


Survey Indices Model 2

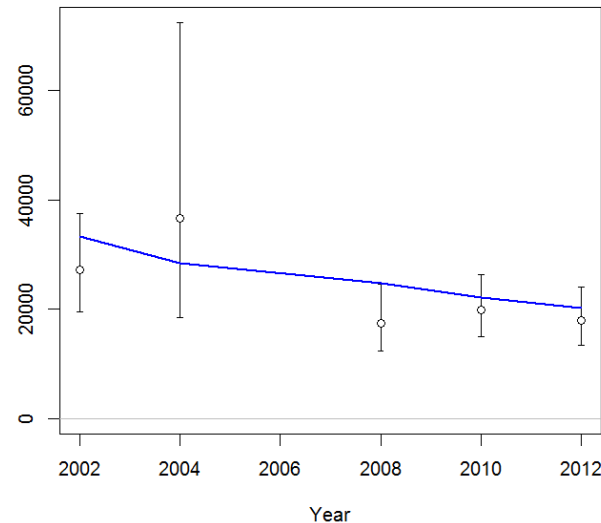


- Similar fits across all models explored
 - Model 2 fits shown below

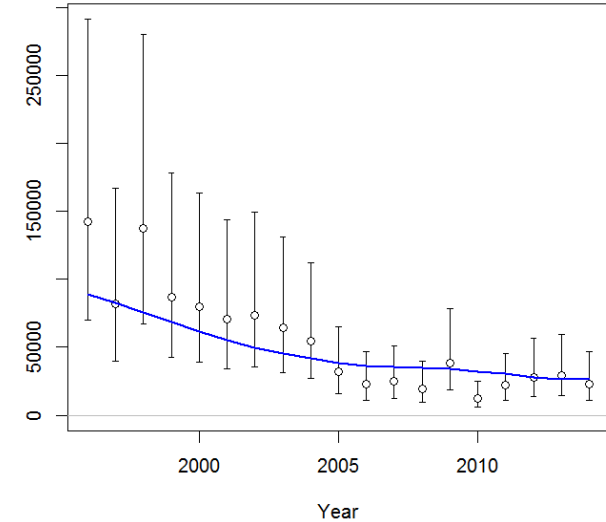
Shelf



Slope



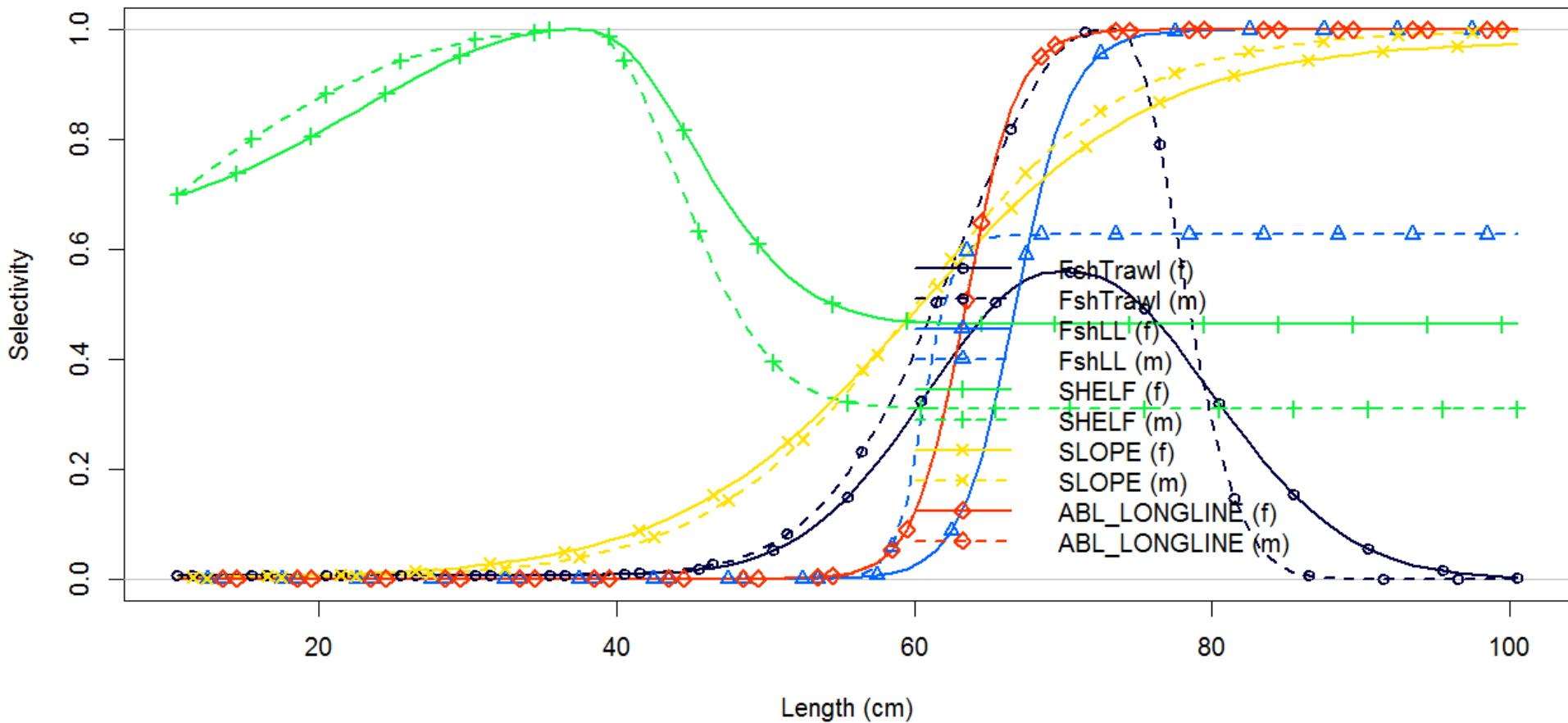
ABL longline



Selectivity Model 2



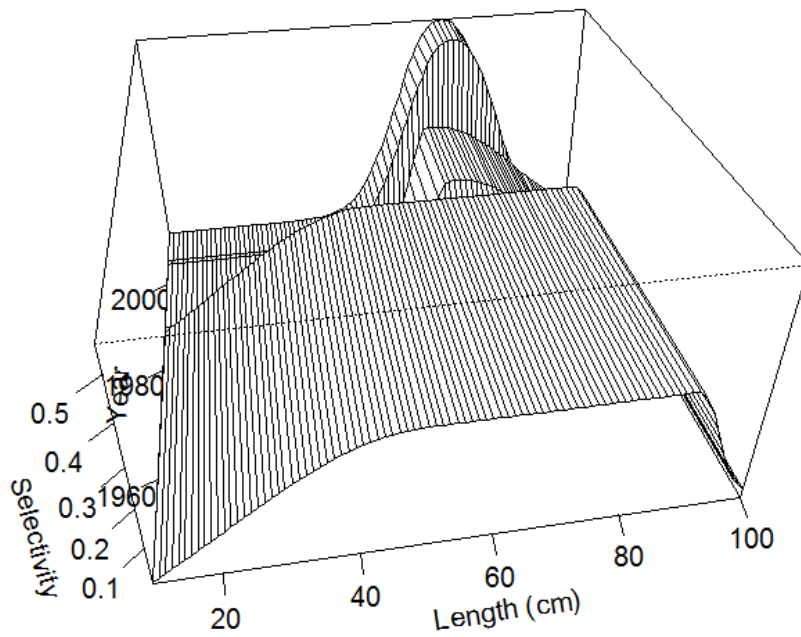
Length-based selectivity by fleet in 2014



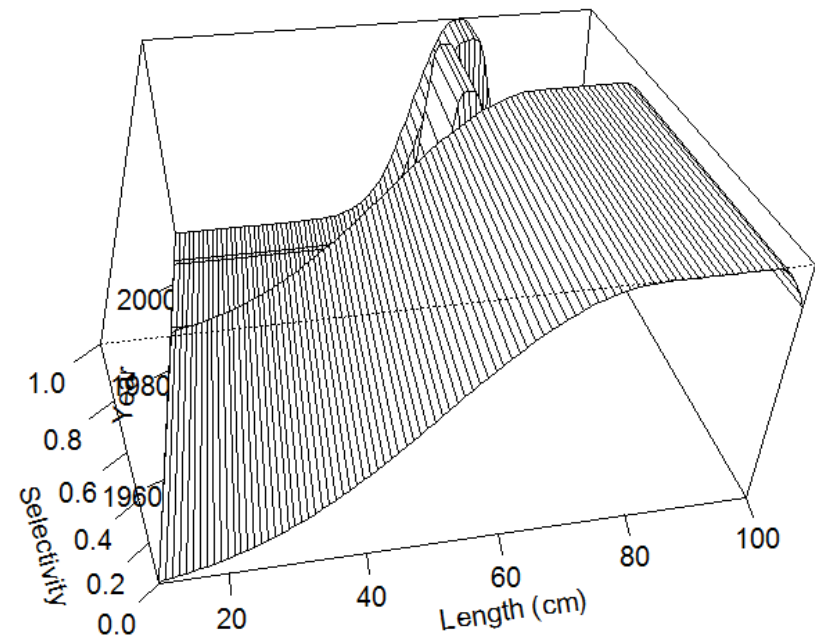
Selectivity – Trawl Fishery Model 2



Females



Males

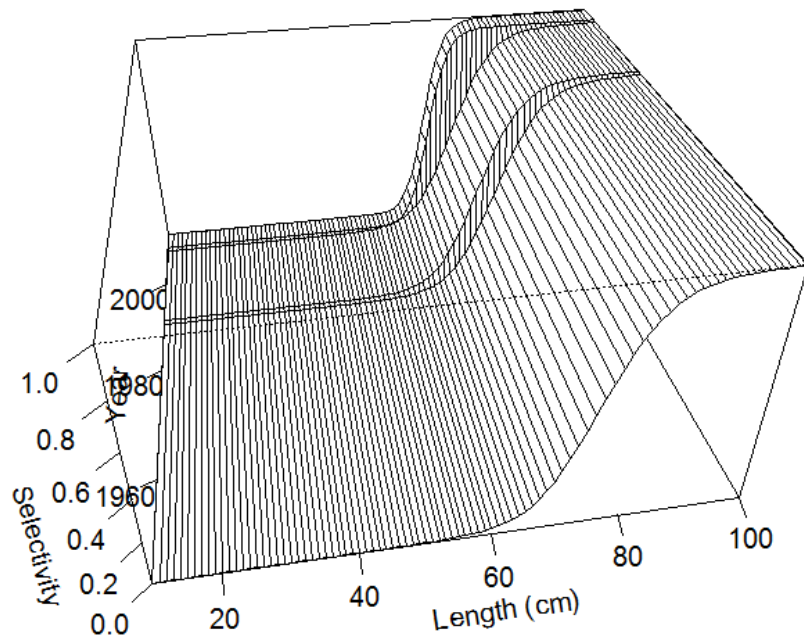


Selectivity – Longline fishery

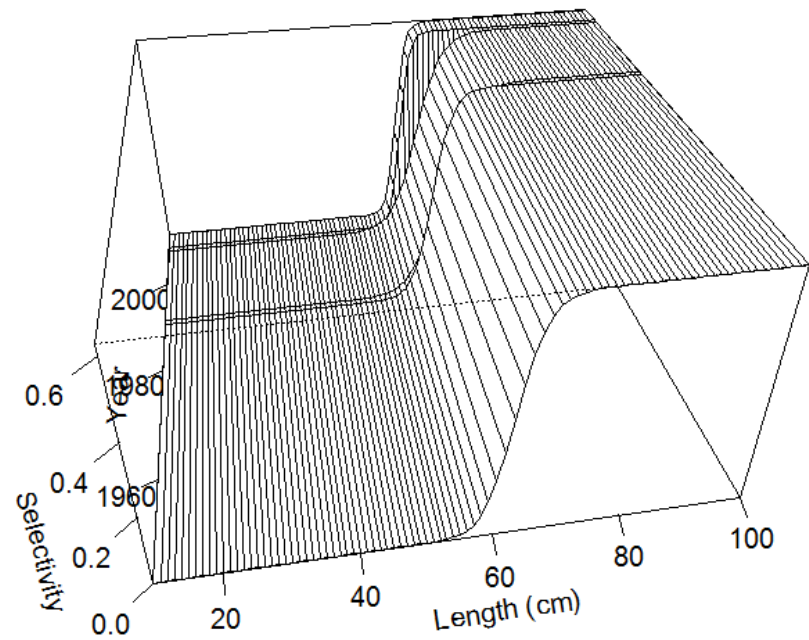
Model 2



Females



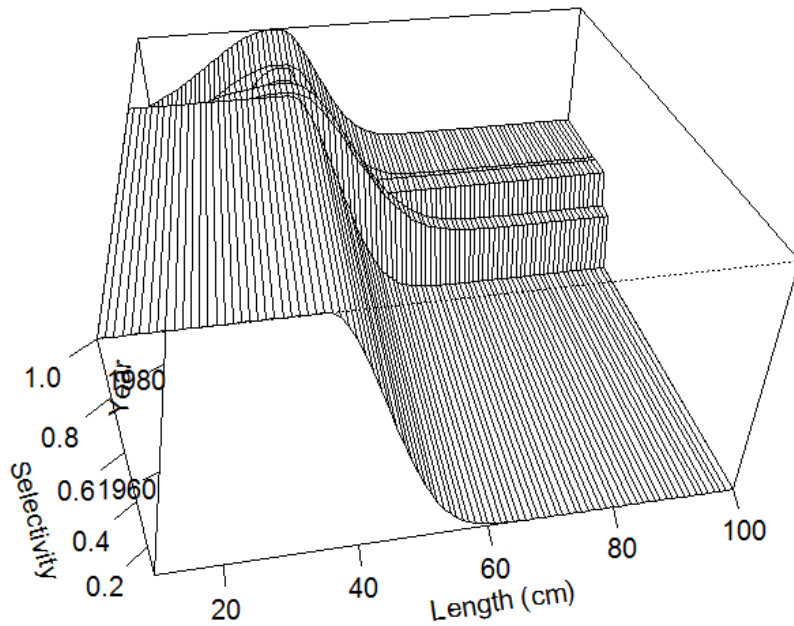
Males



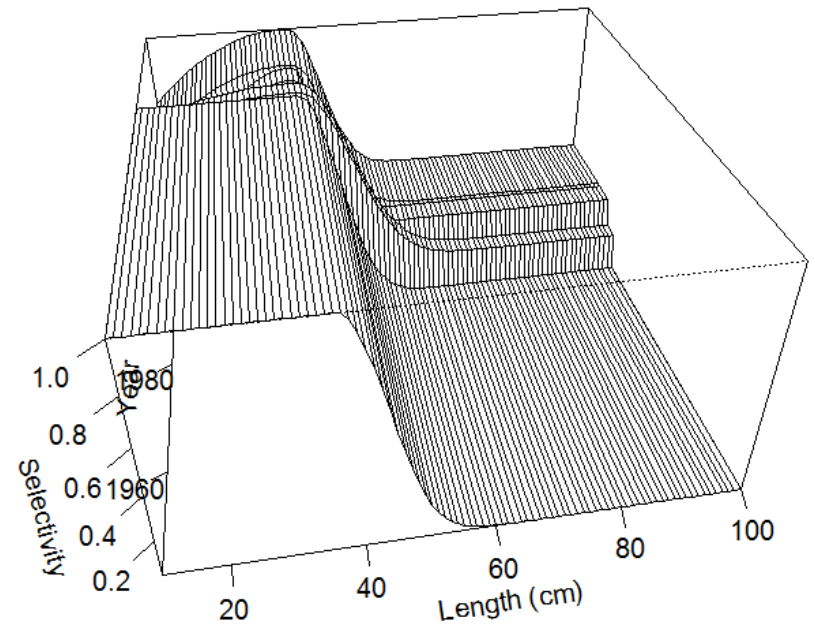
Selectivity – Shelf Survey Model 2



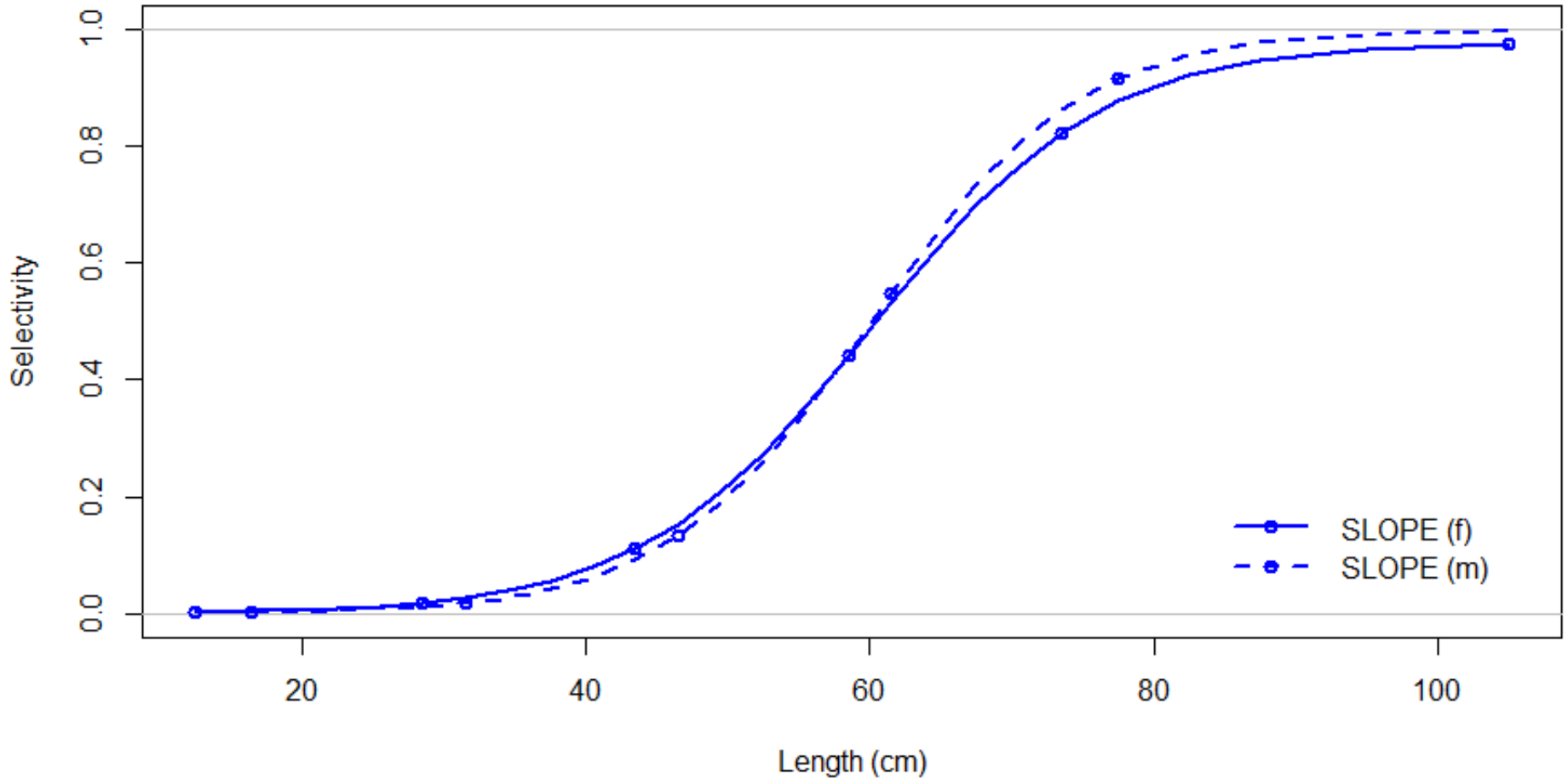
Females



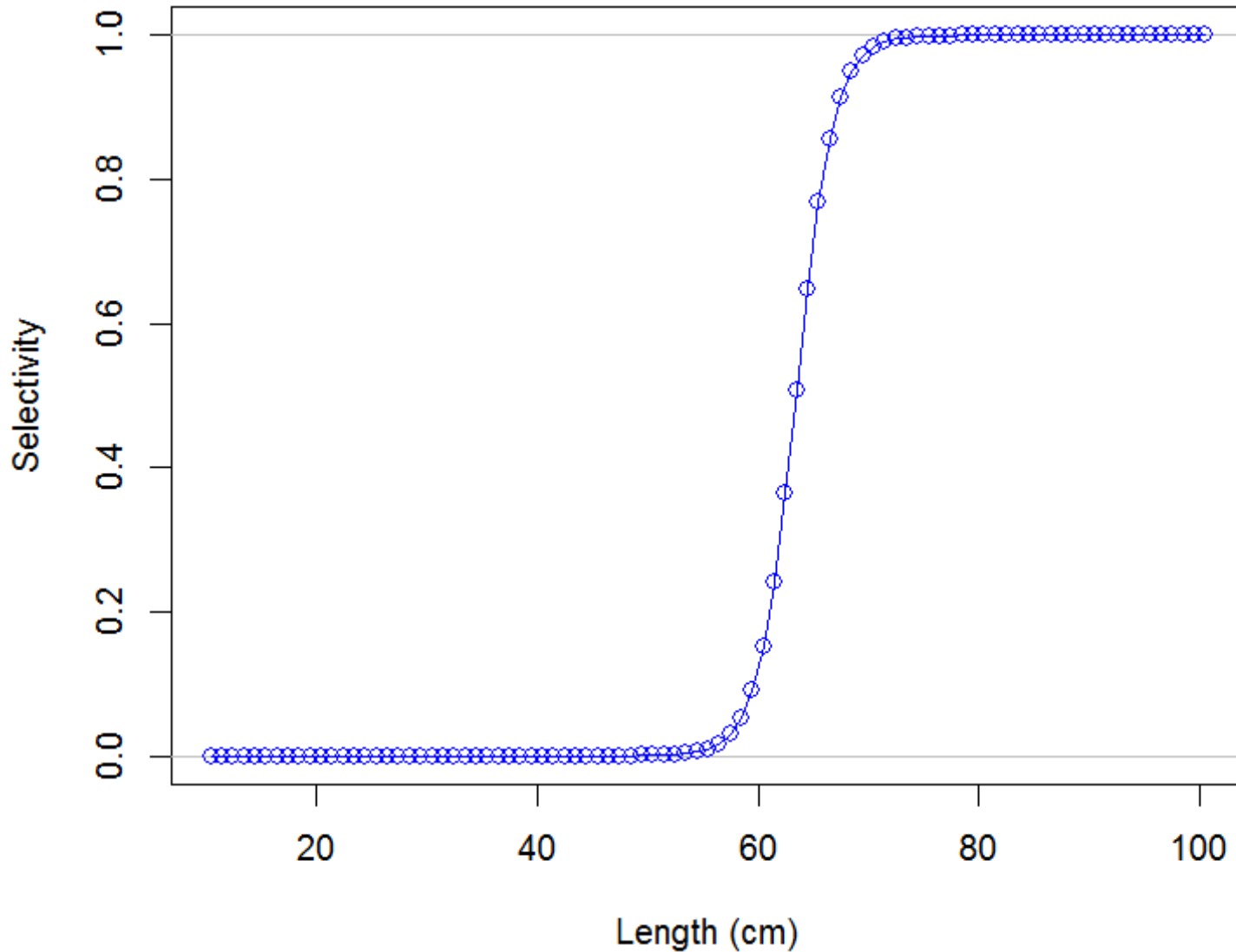
Males



Selectivity – Slope survey Model 2



Selectivity ABL-longline survey

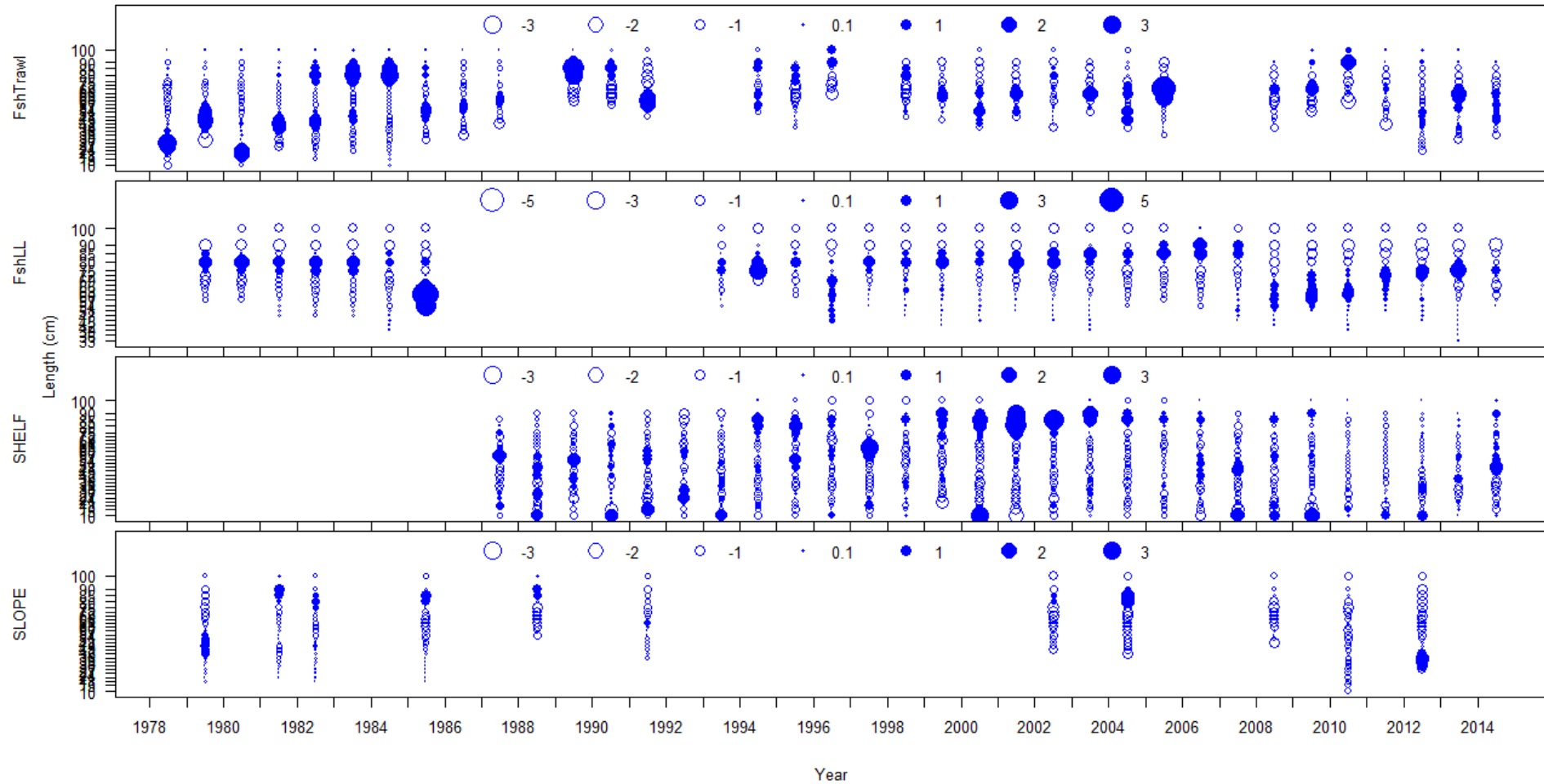


Size composition residuals

Females



Pearson residuals, female, whole catch, comparing across fleets

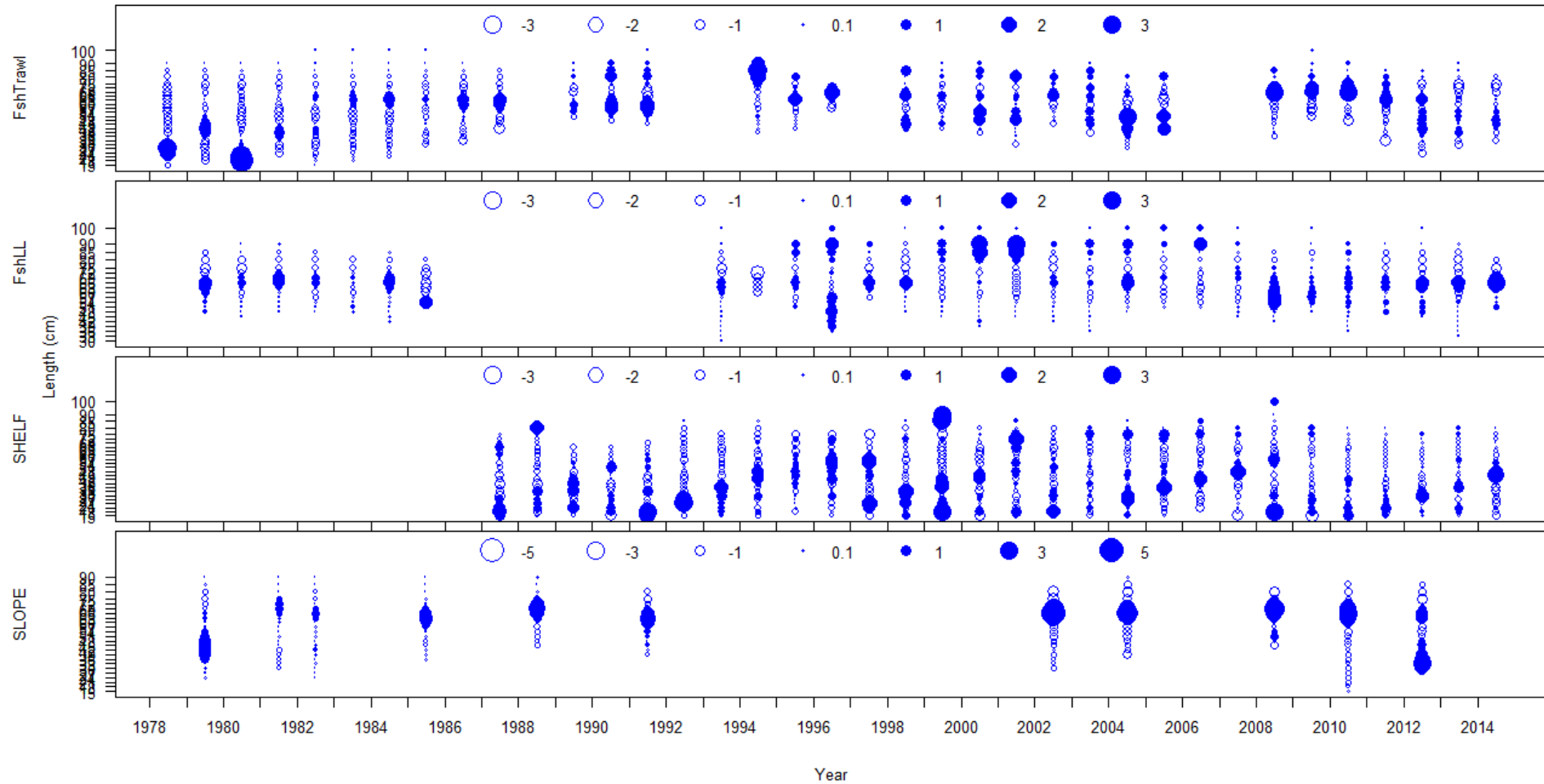


Size composition residuals

Males



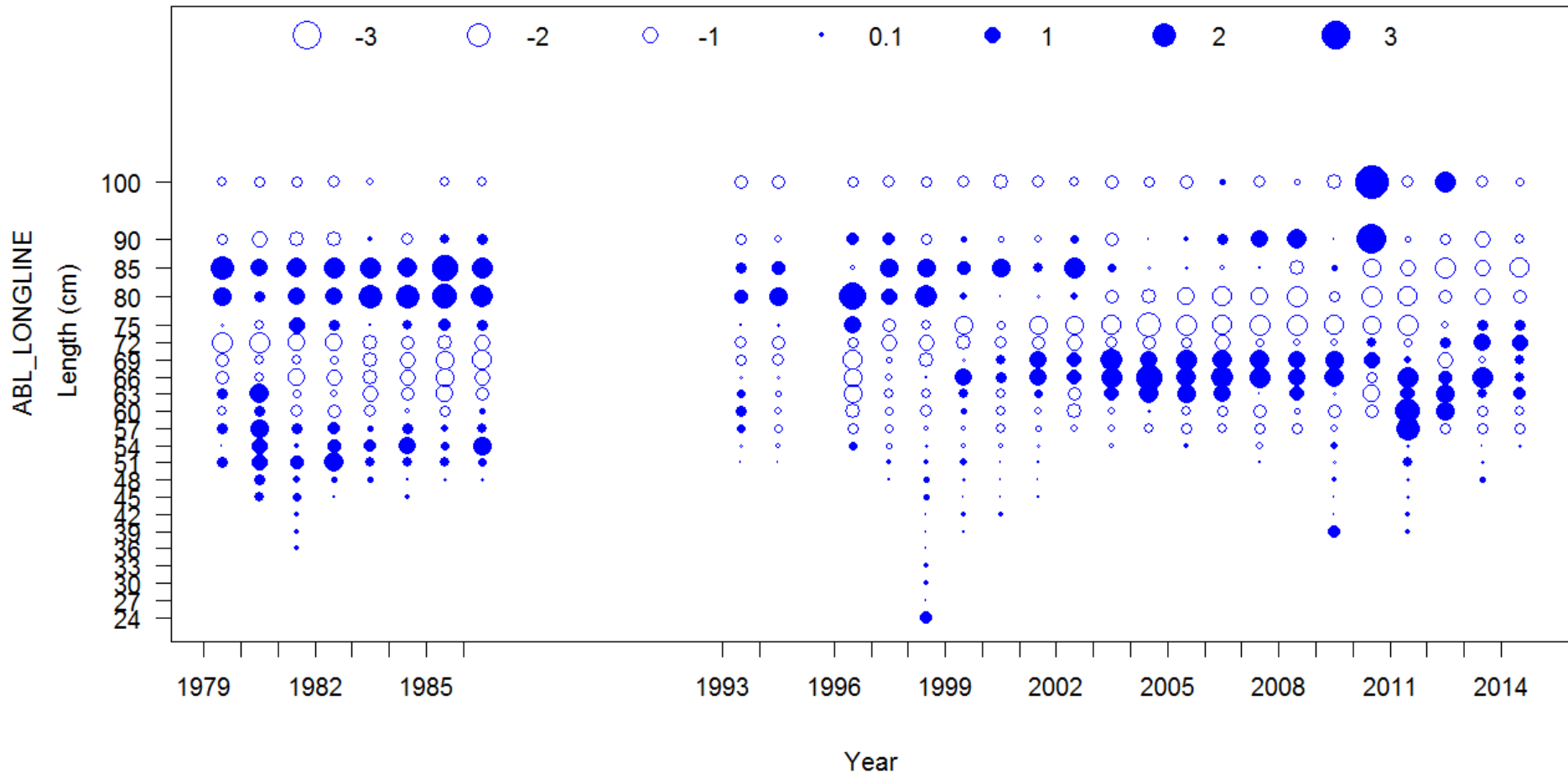
Pearson residuals, male, whole catch, comparing across fleets



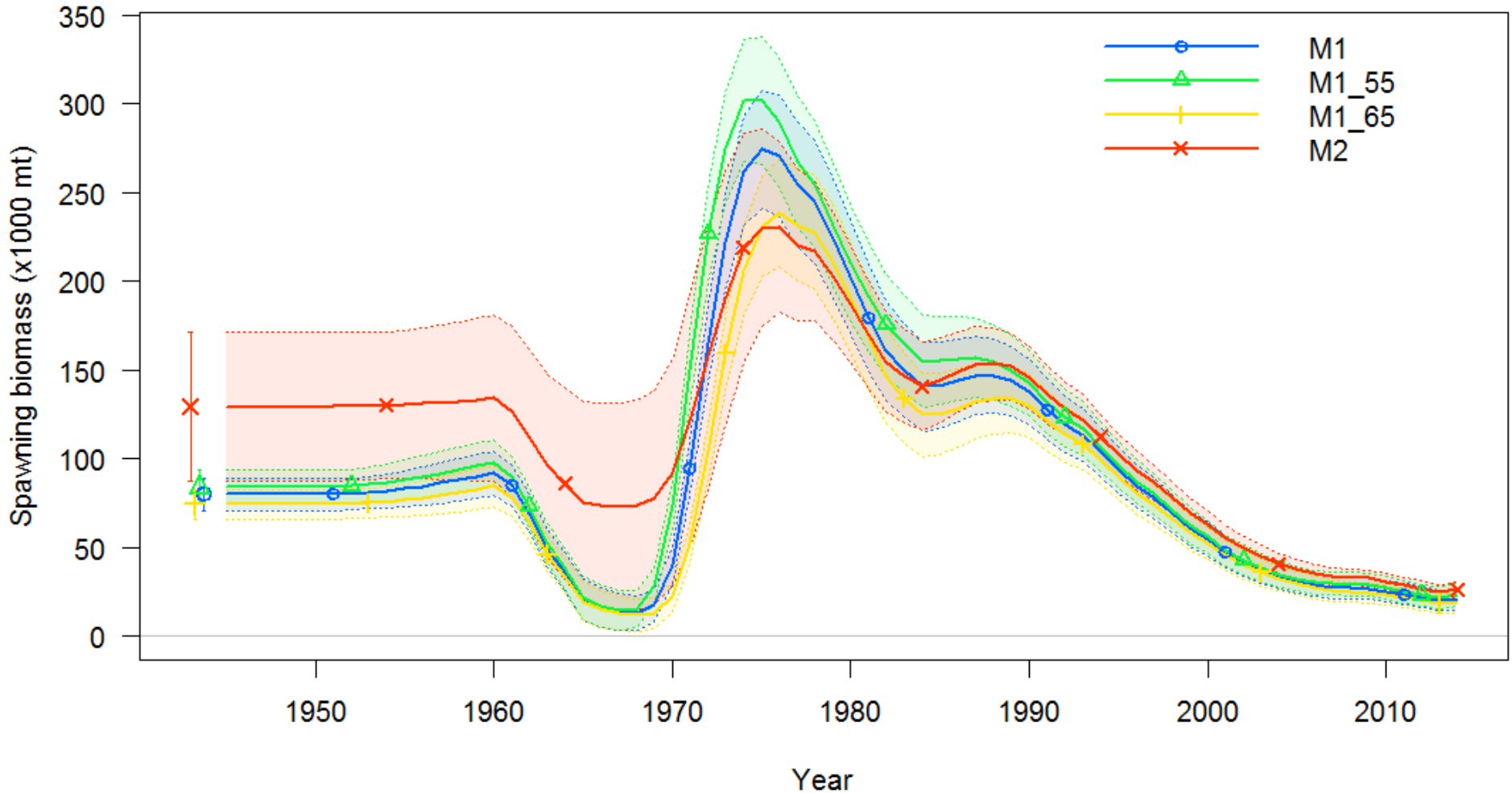
Size composition residuals



Pearson residuals, sexes combined, whole catch, comparing across fleets



Model comparisons

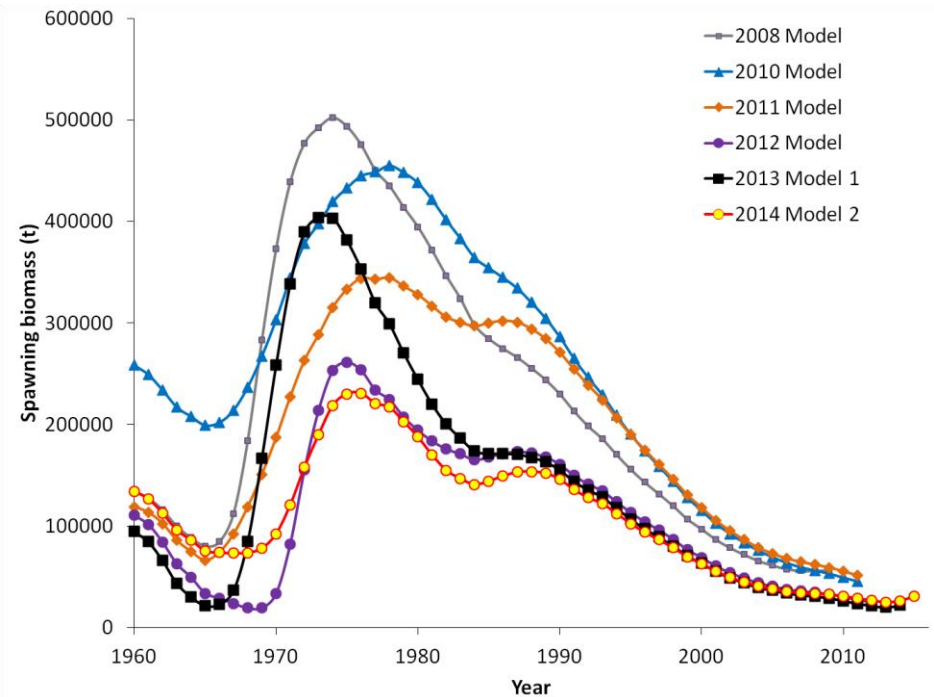
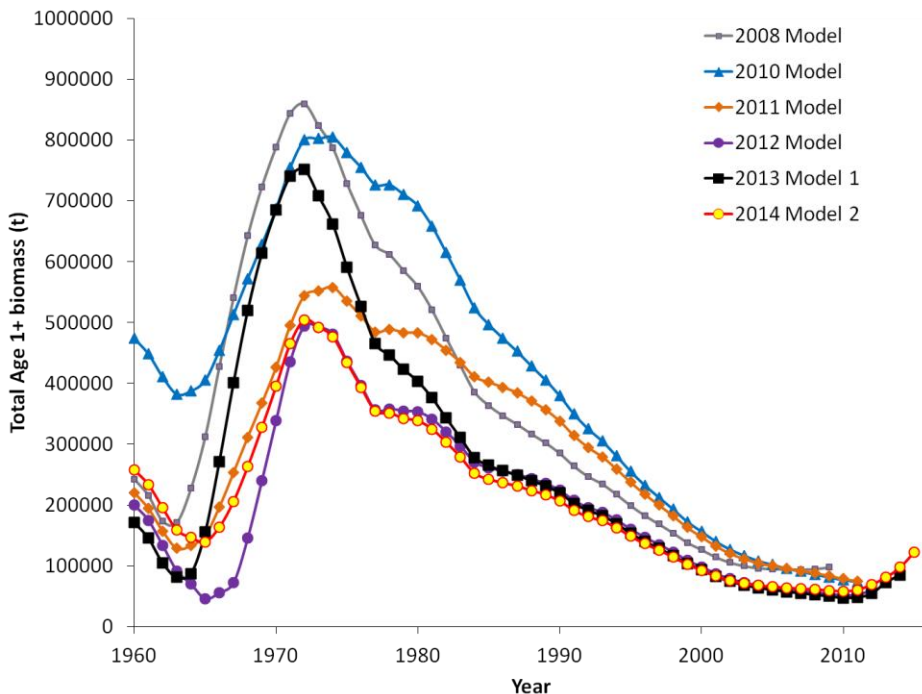


Comparison with past assessments

Model 2

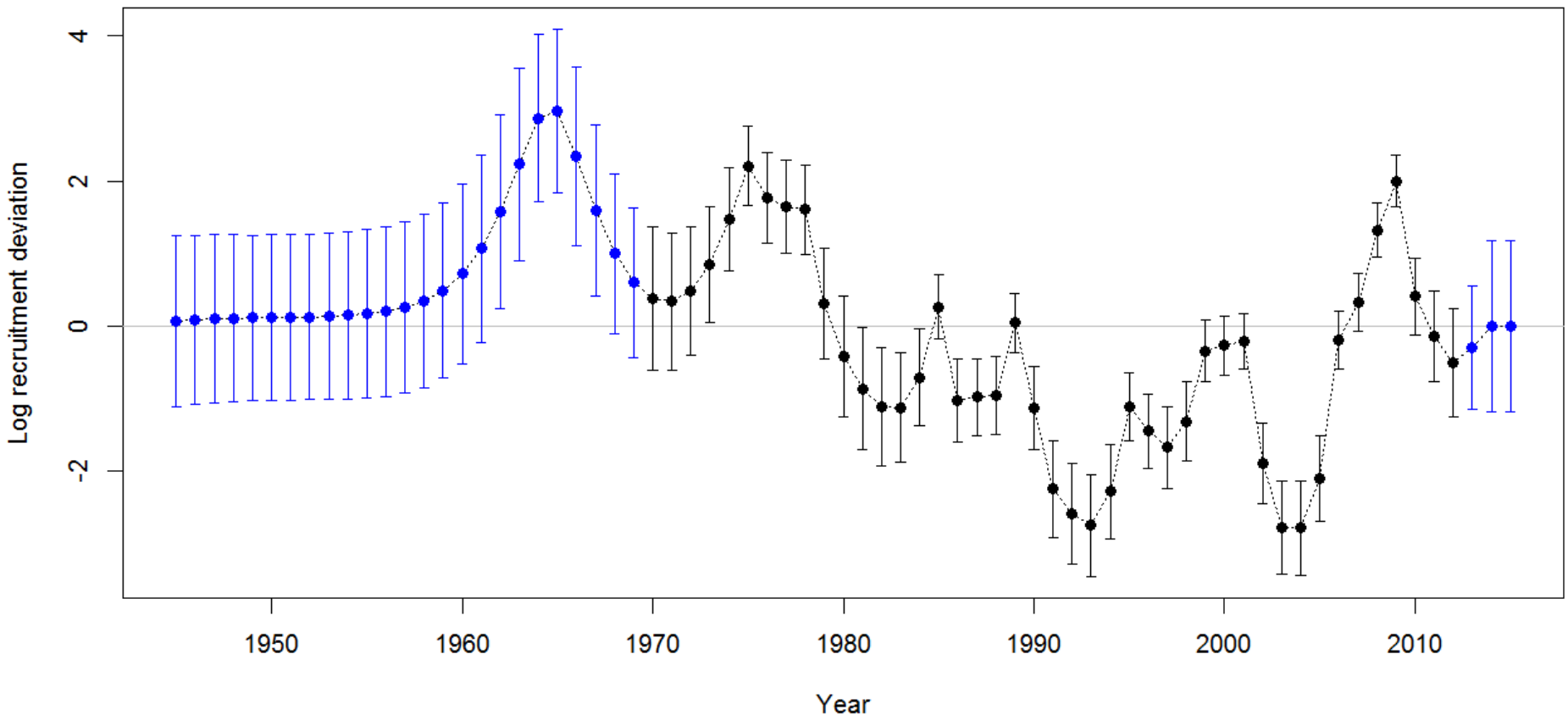


- Lower historical (pre-2000) female spawning and total age 1+ biomass than previous years' assessments
- Higher current (post-2005) biomass levels



Recruitment Model 2

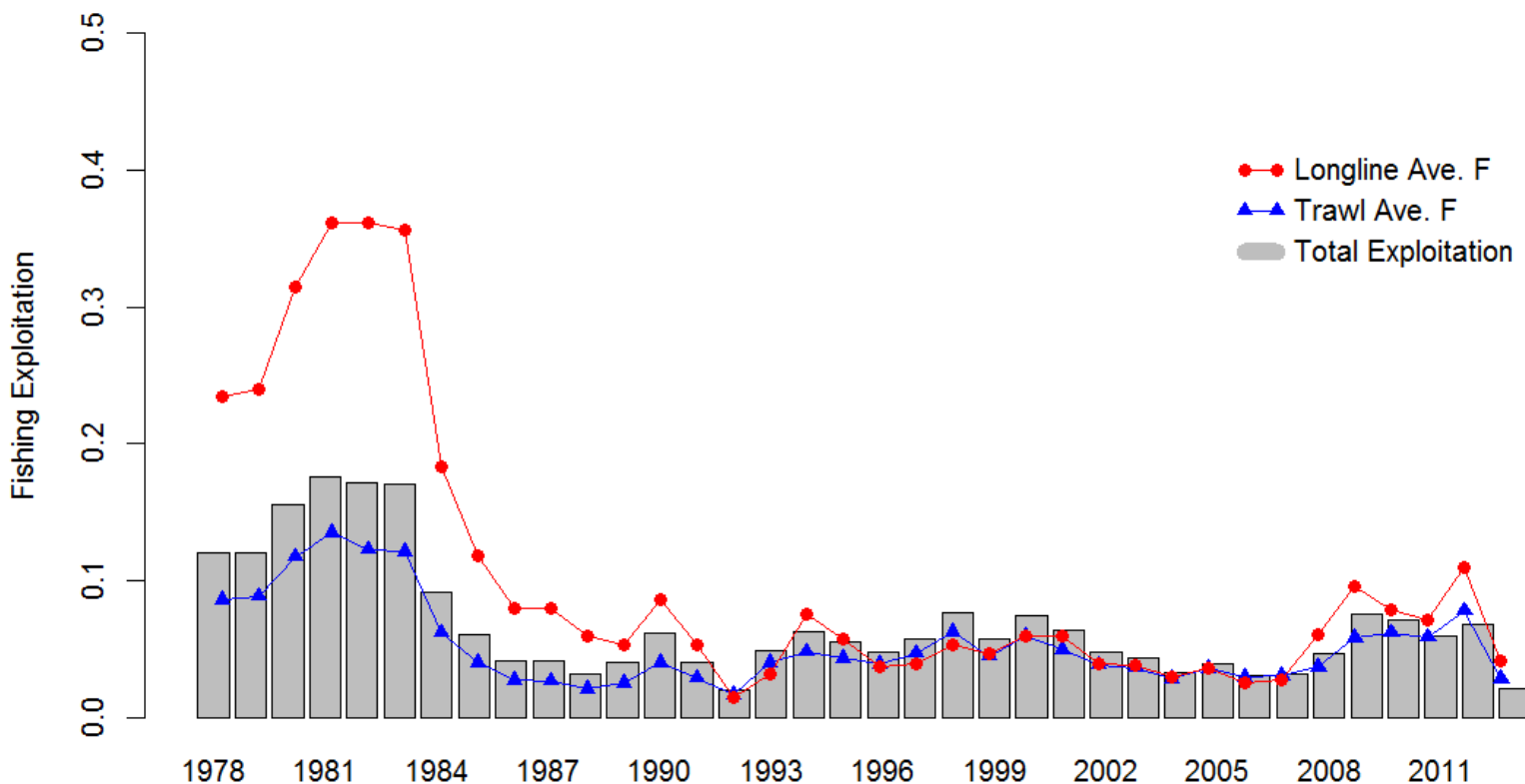
- Poor recruitment between 1979 – 2007
- Large 2008 and 2009 year classes



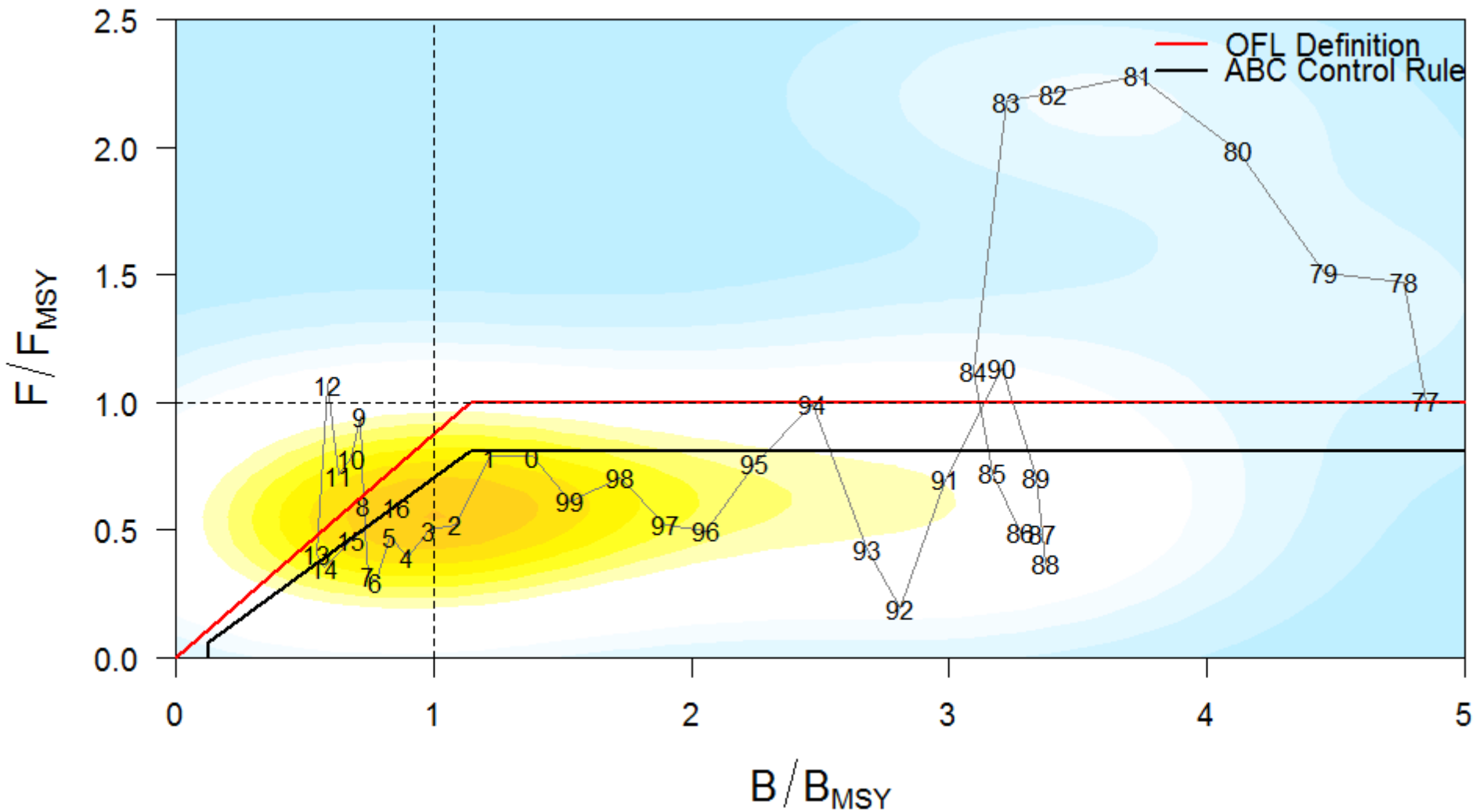
Model 2 – Exploitation rates



- Post-1984 total exploitation rates below natural mortality ($M=0.112$)



Model 2 – Projection

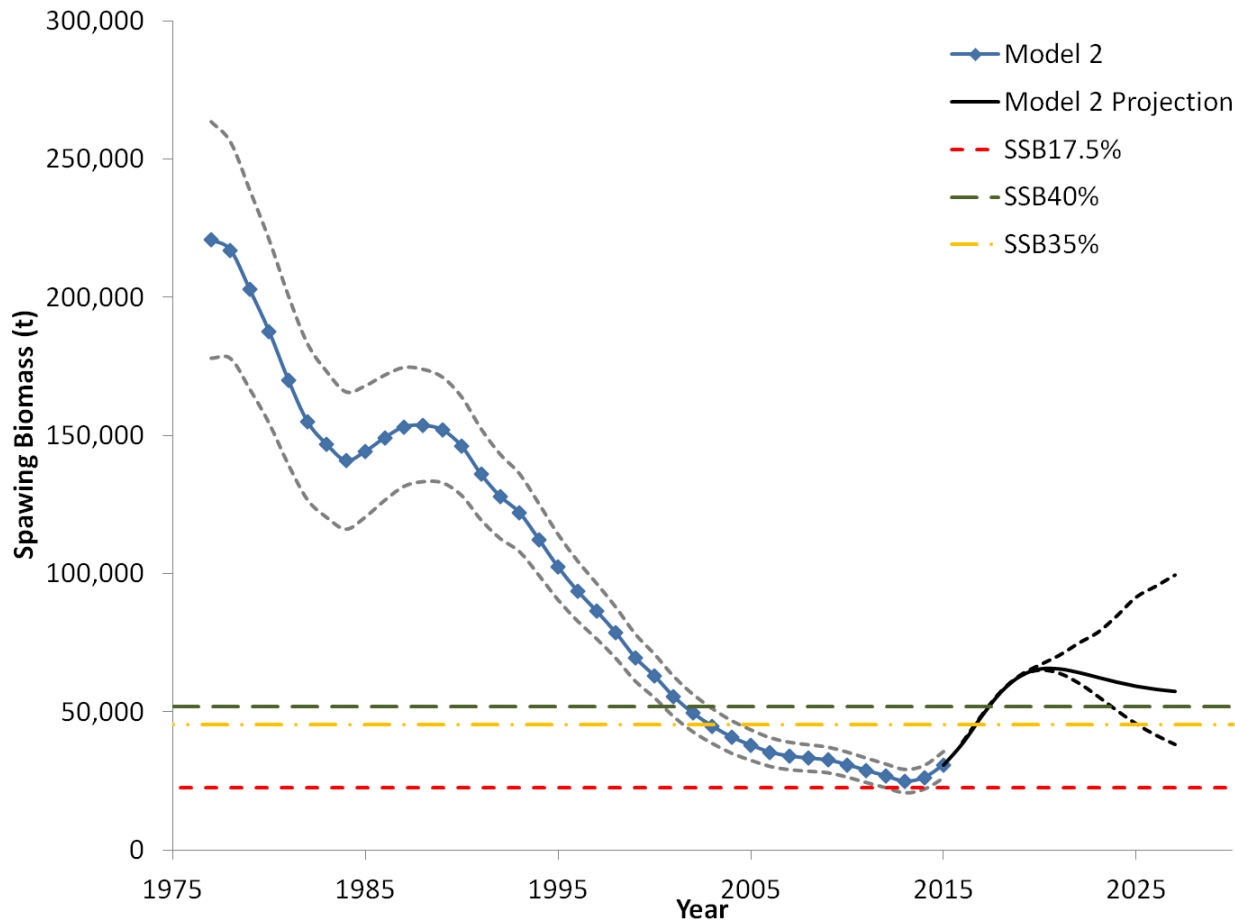


Model 2 – Not overfished

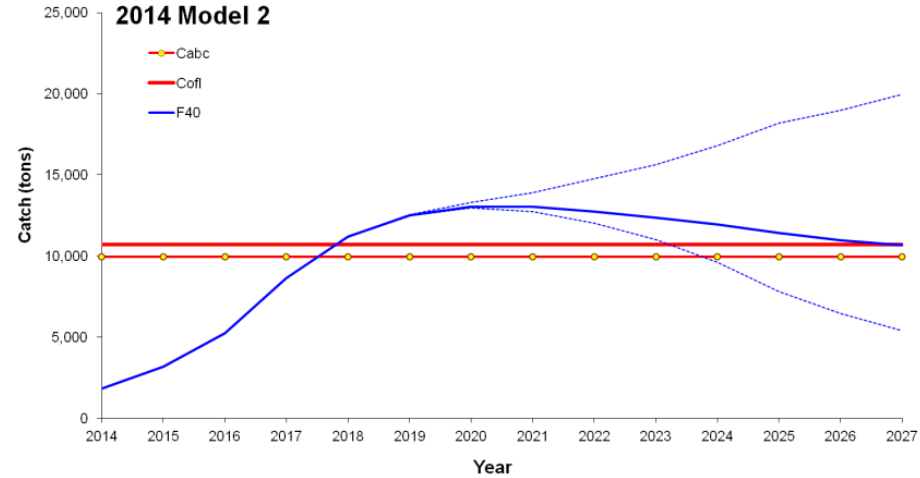
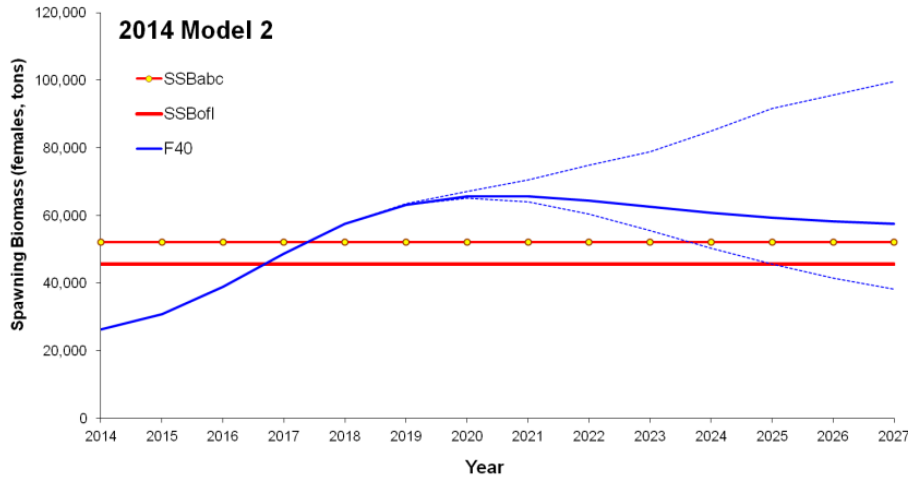


- 2013 estimated at $B_{19\%}$
- 2014 estimated at $B_{20\%}$

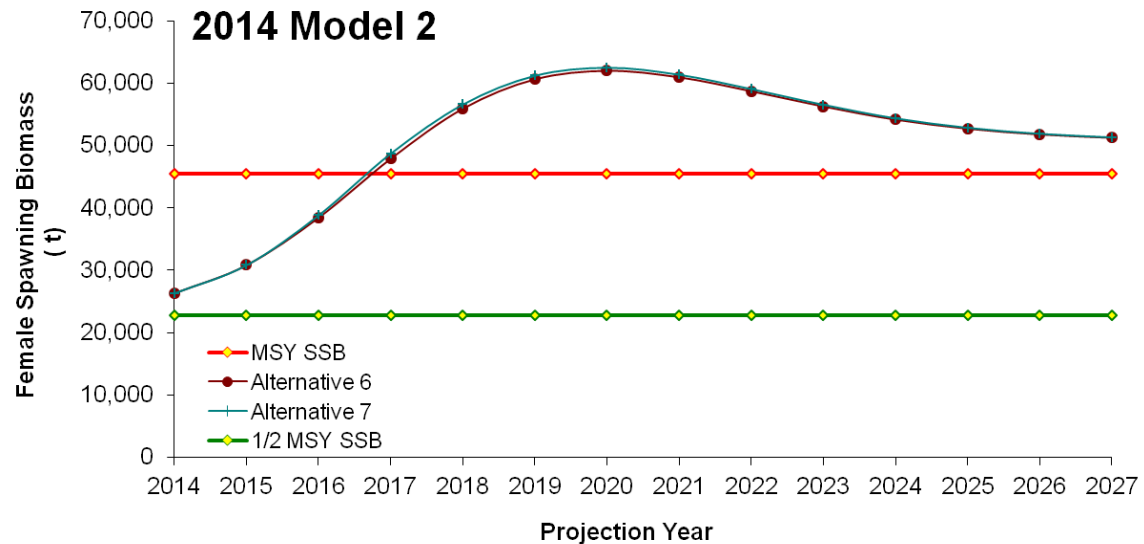
- 2015 projected at $B_{24\%}$
- 2016 projected at $B_{30\%}$



Model 2 – Projection



- Not overfished
- Not overfishing



Summary results

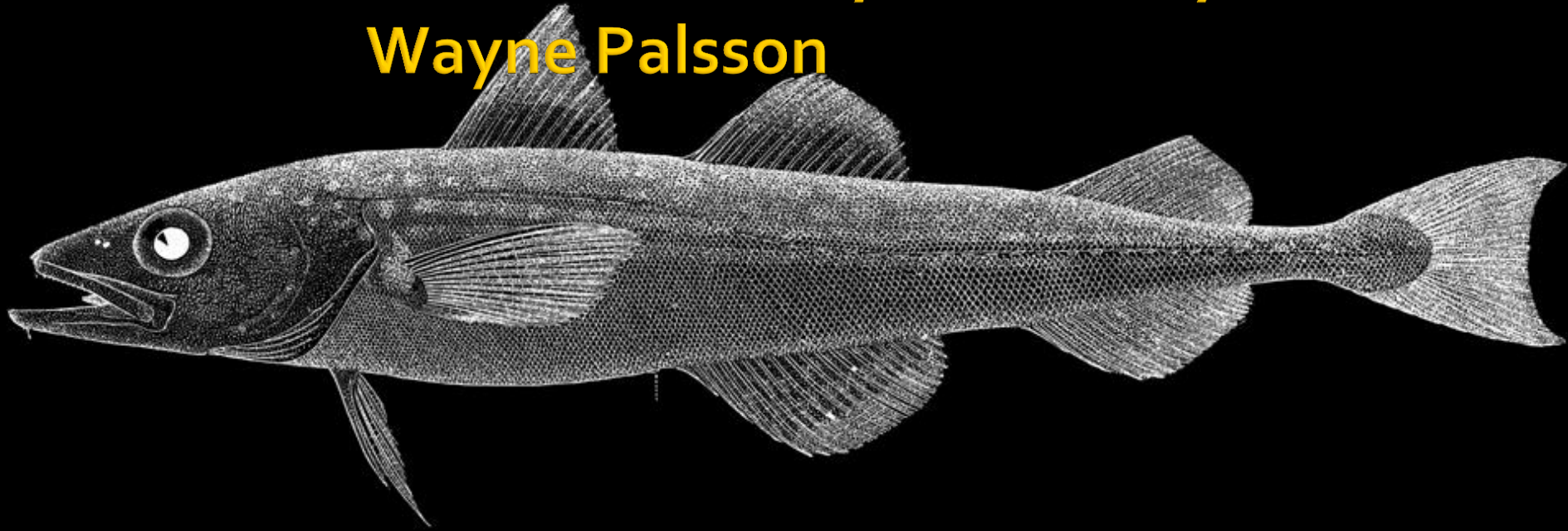
Model 2



Quantity	As estimated or <i>specified last year for:</i>		As estimated or <i>recommended this year for:</i>	
	2014	2015	2015	2016
M (natural mortality rate)	0.112	0.112	0.112	0.112
Tier	3b	3b	3b	3b
Projected total (age 1+) biomass (t)	84,546	96,298	122,298	132,666
Female spawning biomass (t)	22,010	27,624	30,853	38,848
$B_{100\%}$	99,764	99,764	130,123	130,123
OFL (t)	2,647	3,864	3,903	6,453
maxABC (t)	2,124	3,173	3,172	5,284
ABC (t)	2,124	3,173	3,172	5,284
EBS	1,659	2,478	2,448	4,050
(22.8%) Aleutian Islands	465	695	724	1,198
Status	As determined <i>last year for:</i>		As determined <i>this year for:</i>	
	2012	2013	2013	2014
Overfishing	No	n/a	No	n/a
Overfished	n/a	No	n/a	No
Approaching overfished	n/a	No	n/a	No

Assessment of the pollock stock in the Aleutian Islands

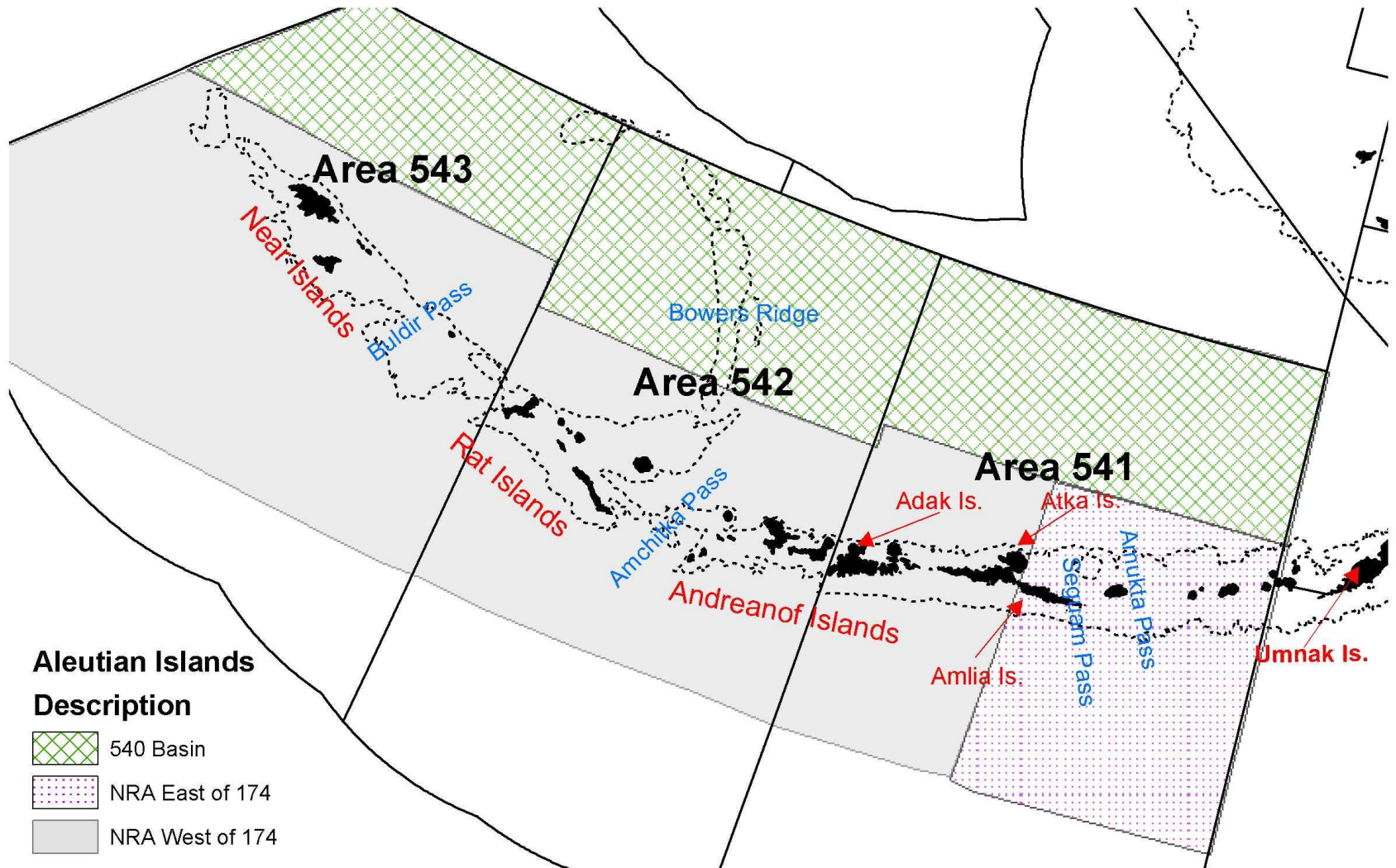
Authors: Steve Barbeaux, Jim Ianelli, and Wayne Palsson



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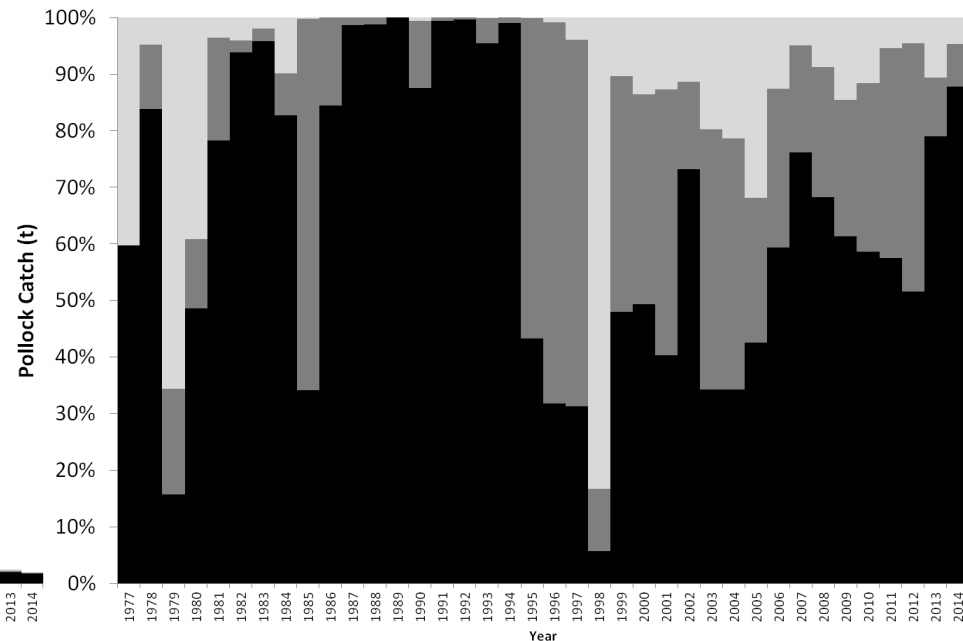
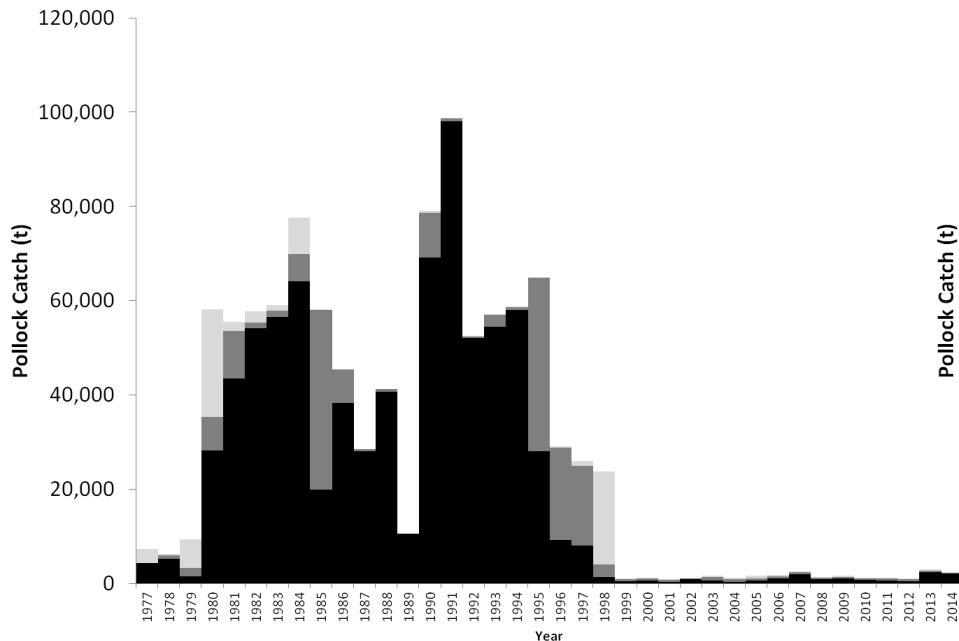
AI pollock area



AI pollock fishery

- No directed fishery since 2010
 - Bycatch only
 - Catch < 3,000 t since 1999

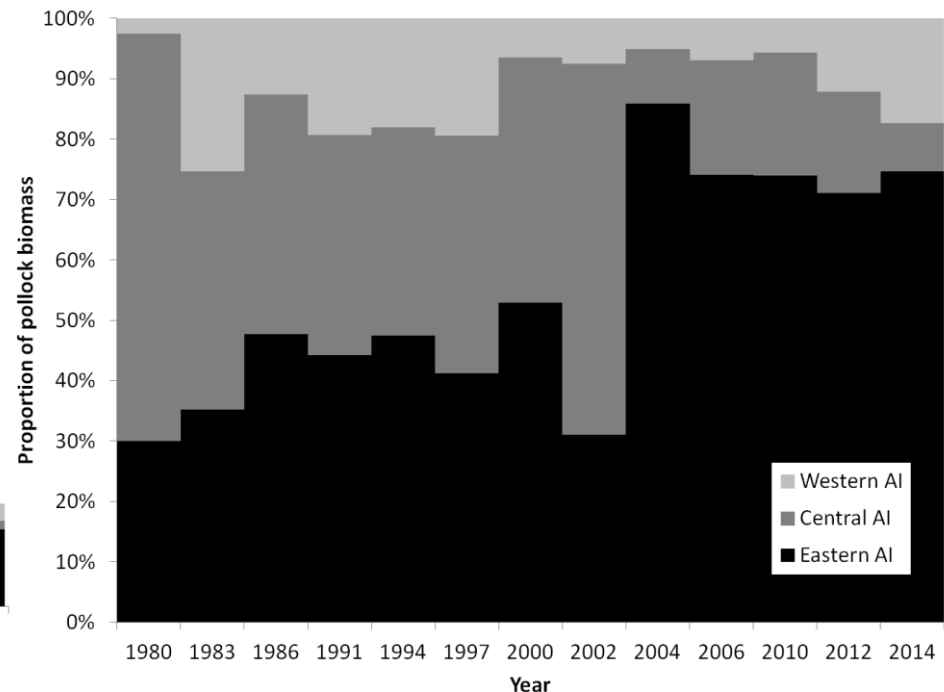
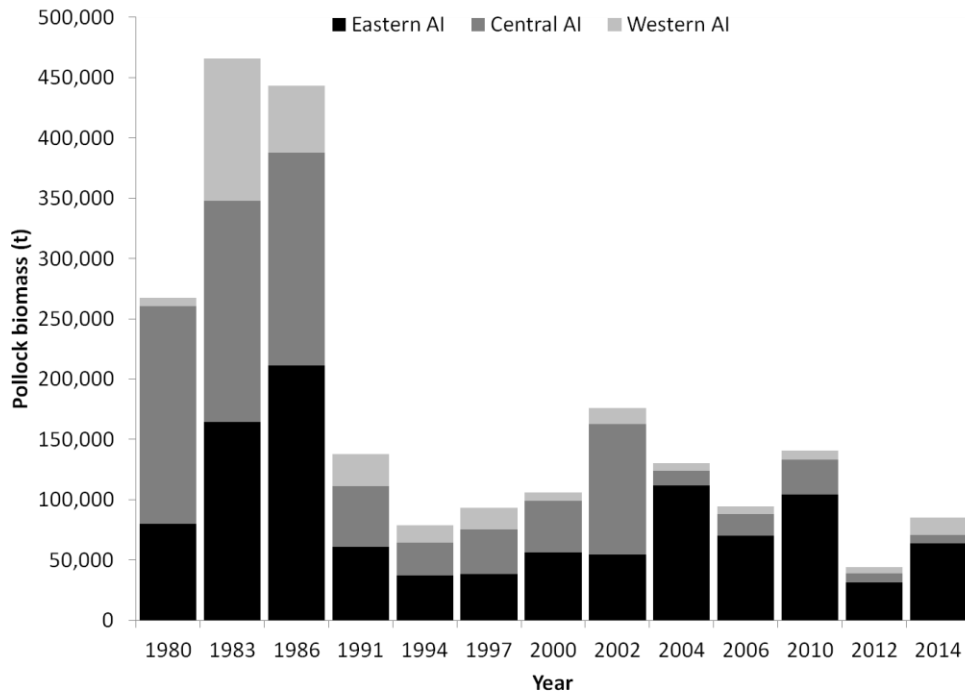
■ Eastern AI ■ Central AI ■ Western AI





AI bottom trawl survey

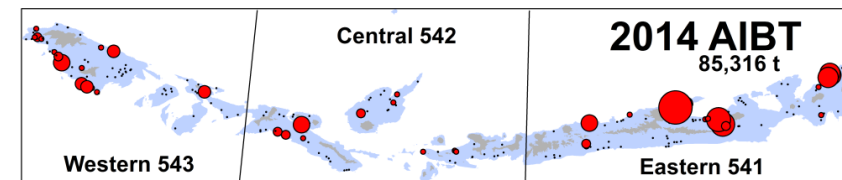
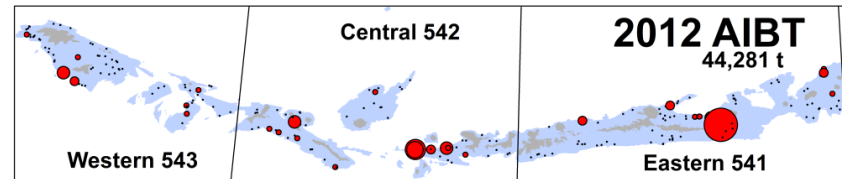
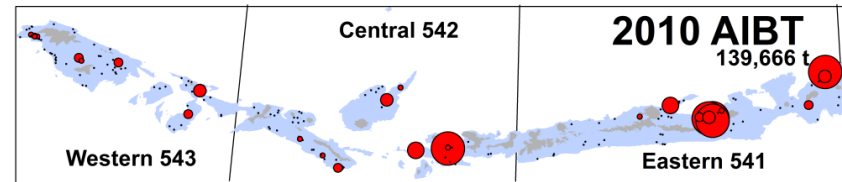
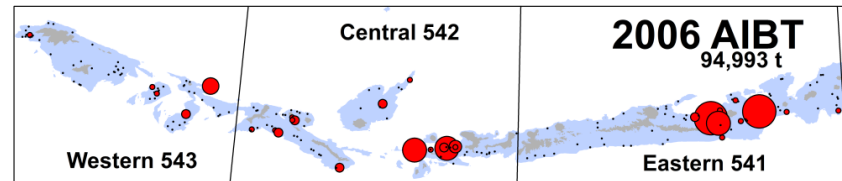
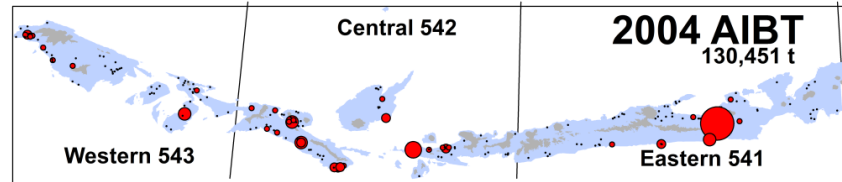
- 2014 Biomass up
 - 85,316 t from 44,281t
 - Remains low
 - Biomass concentrated in the east since 2004





A1 bottom trawl survey

- Patchy distribution



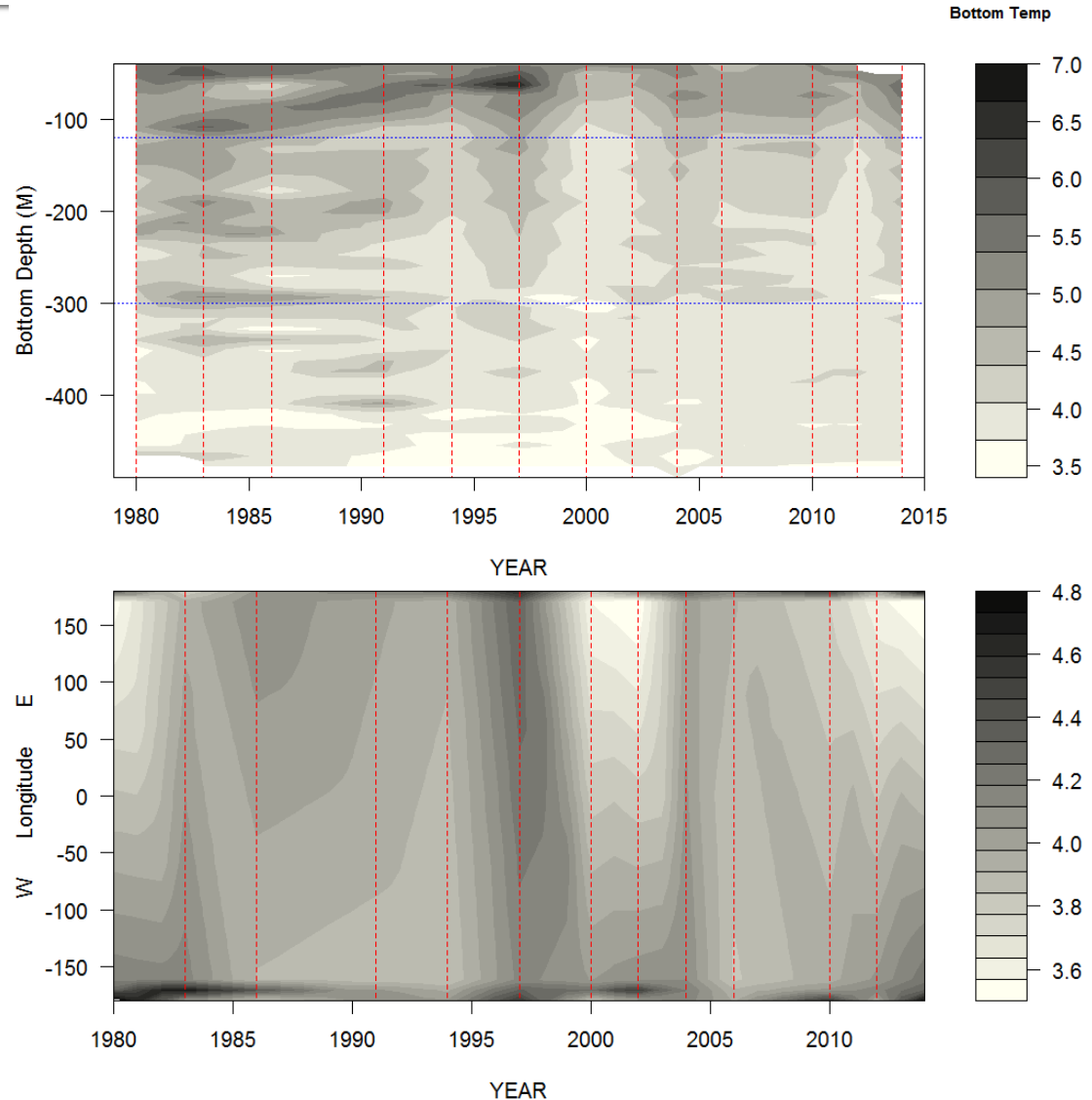
CPUE (tkm⁻²)

- 1 - 1,000
- 1,001 - 3,000
- 3,001 - 6,000
- 6,001 - 12,000
- 12,001 - 25,000
- 25,001 - 50,000
- 50,001 - 75,000
- 75,001 - 500,000



AI bottom trawl survey

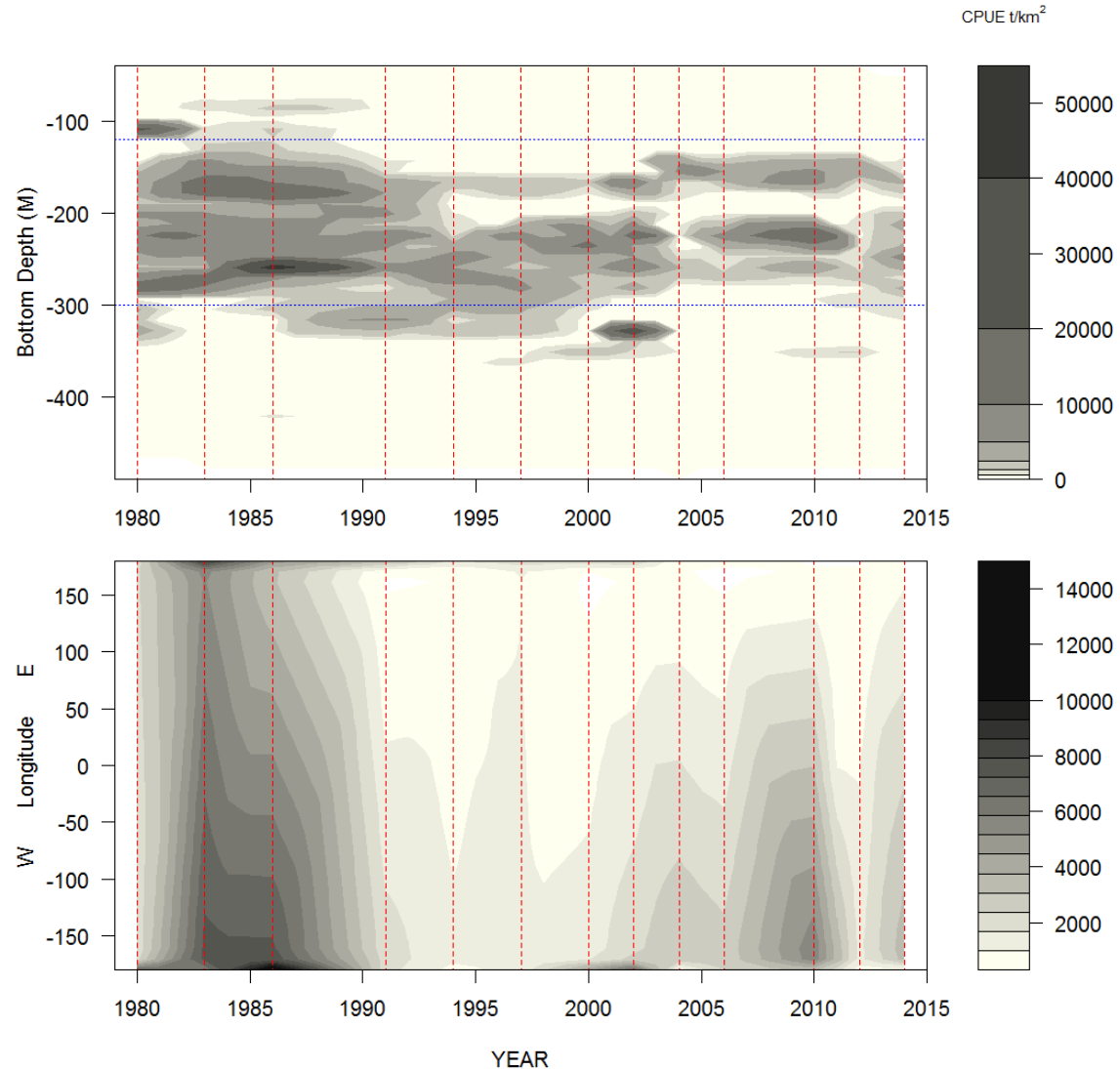
- Temperature changes from 2012
- Warming in the shallow bottom depths
- Warming in the East
- Cooling in the West





AI bottom trawl survey

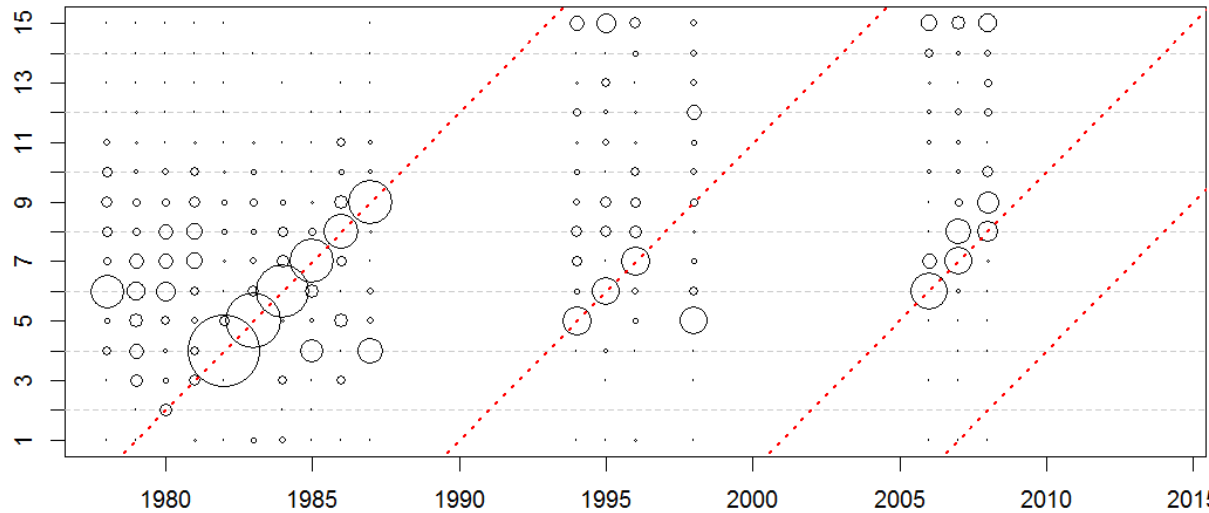
- Same depths across years
- 2014 increased CPUE in the Eastern AI from 2012



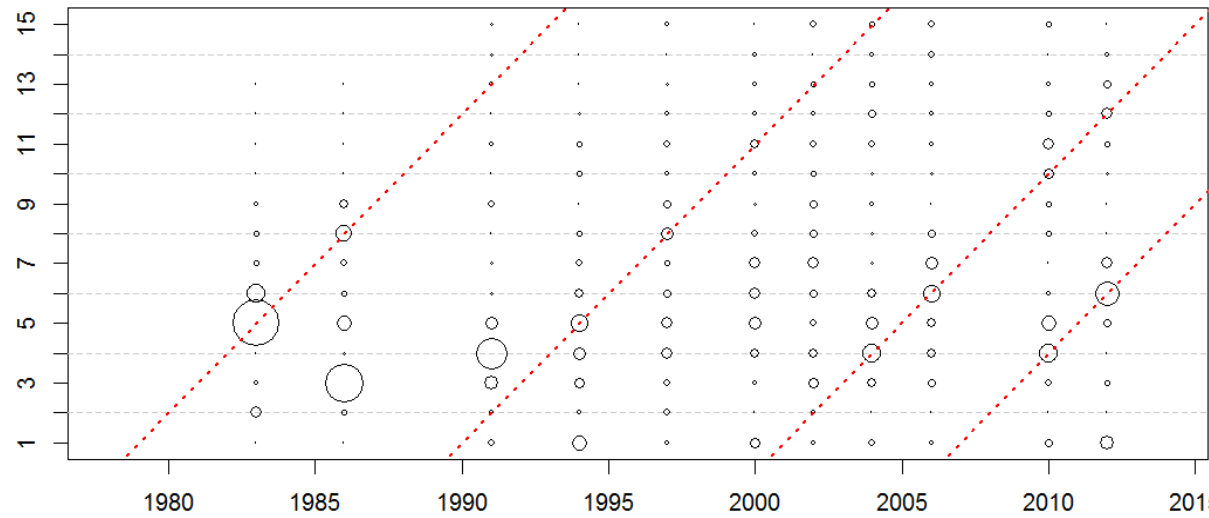


AI pollock age composition

Fishery age composition

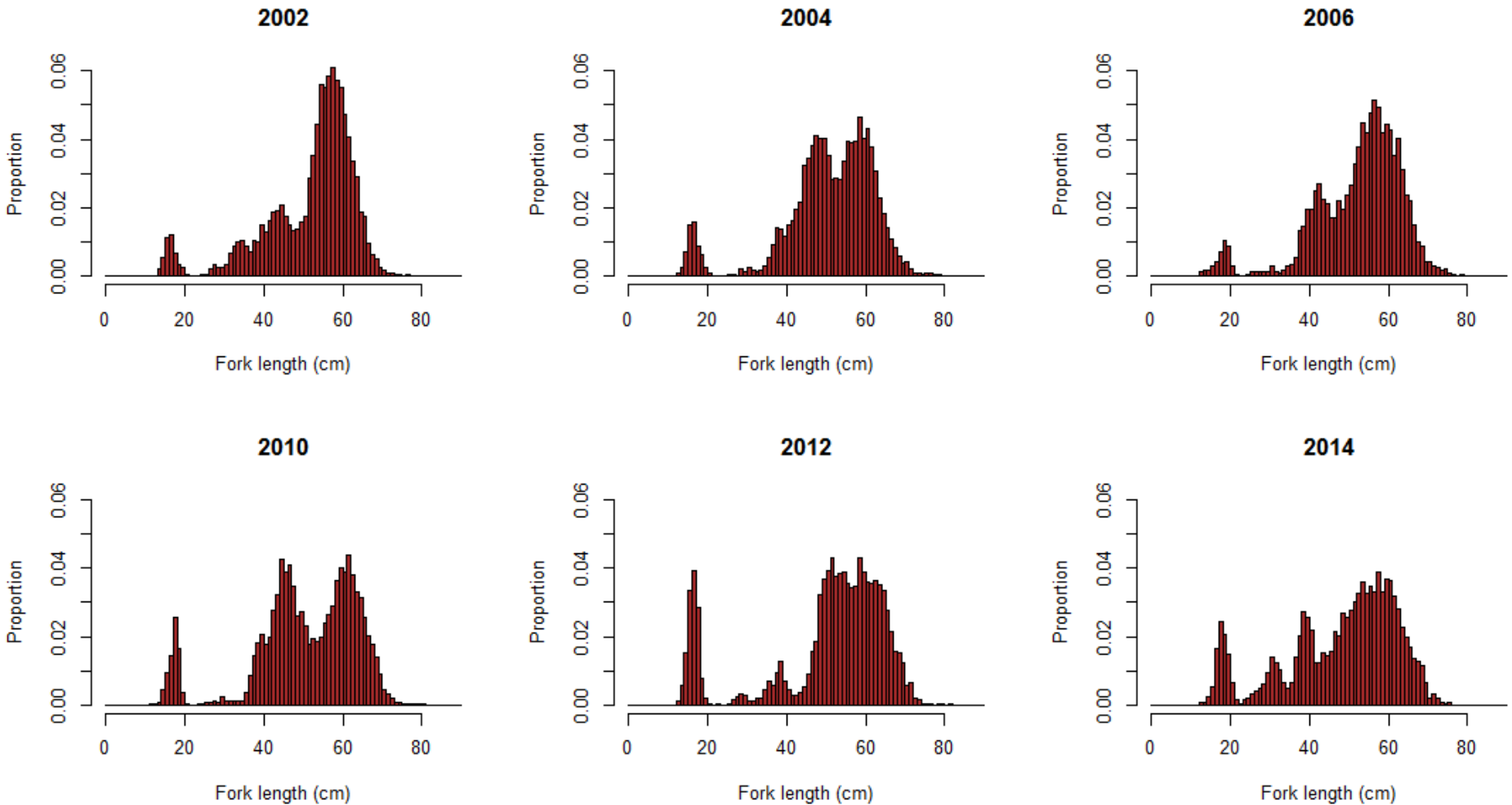


Survey age composition





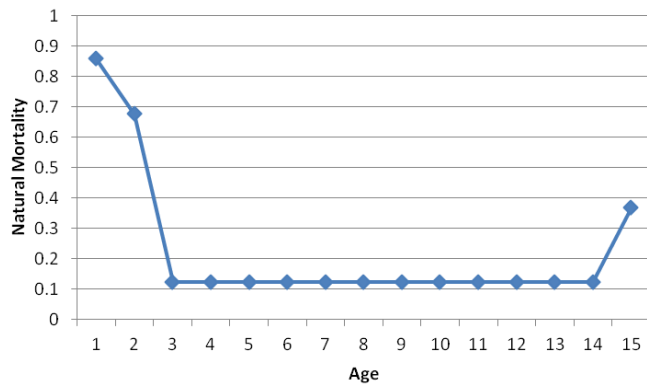
AI survey size composition





Models for 2014

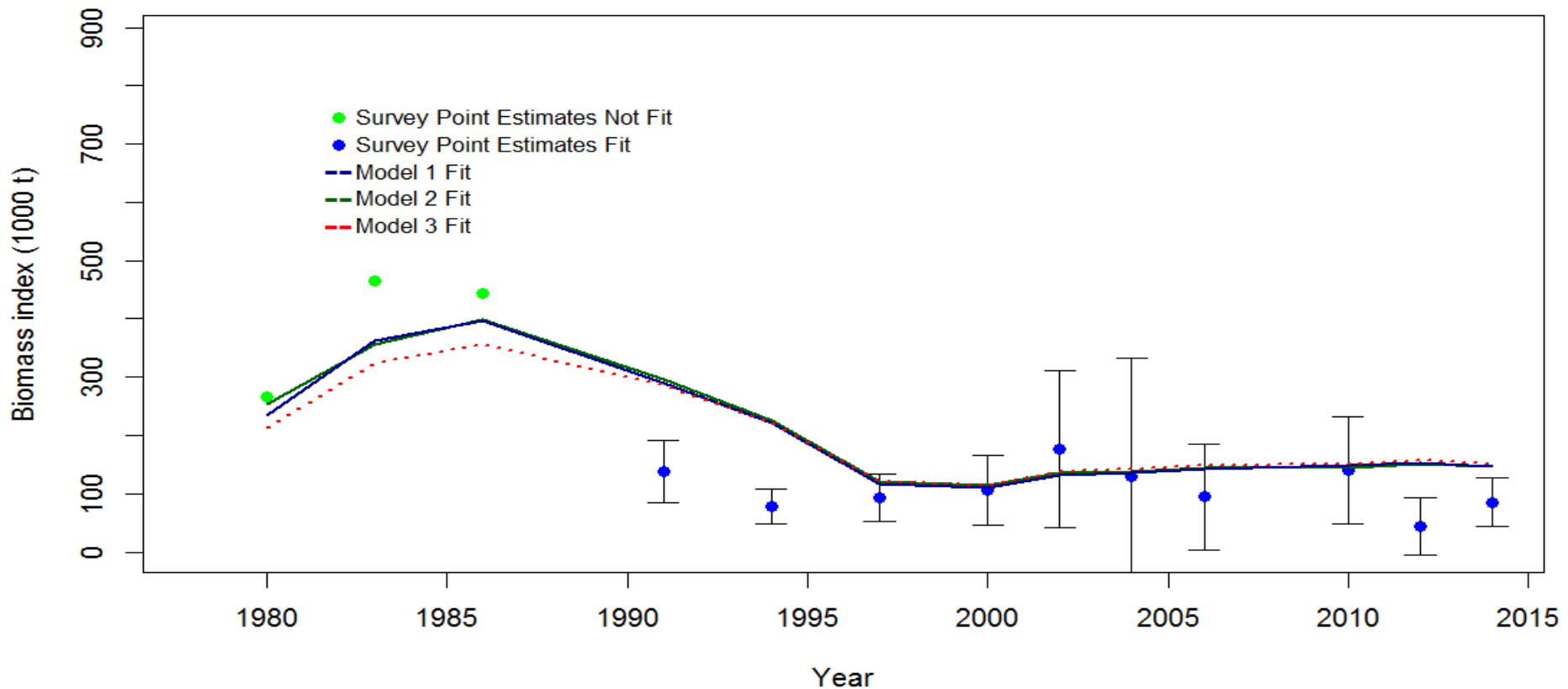
- Model 1
 - Same as 2013 preferred model
- Model 2
 - Model 1 with Age 1
- Model 3
 - Model 2 with a vector for natural mortality





Fit to AI bottom trawl survey

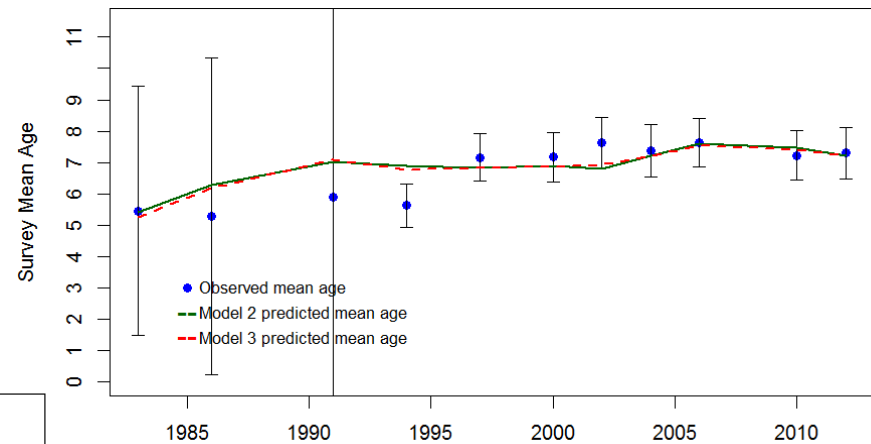
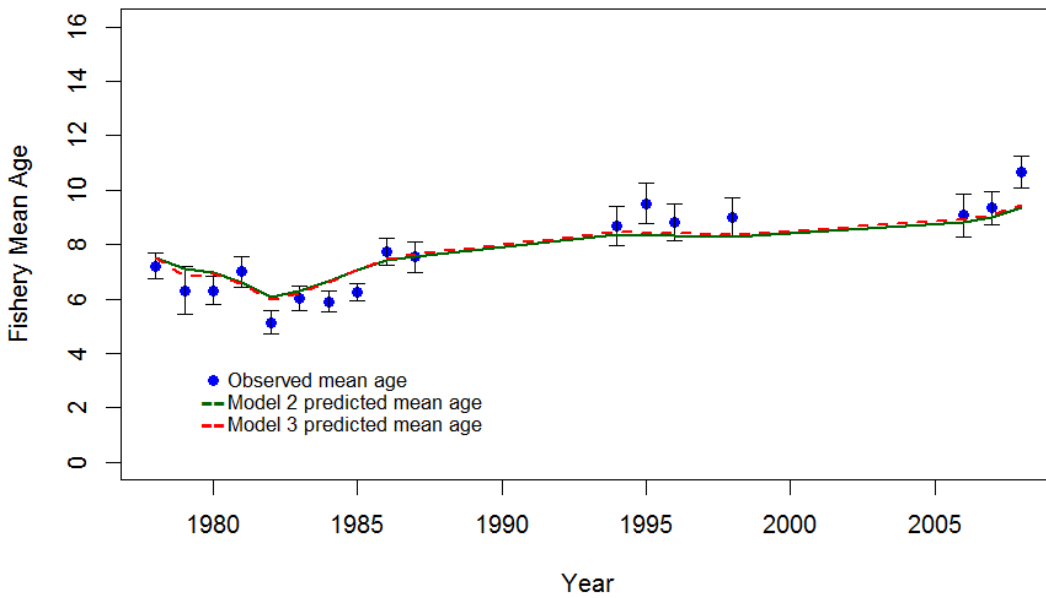
- Poor fit to the survey for all Models



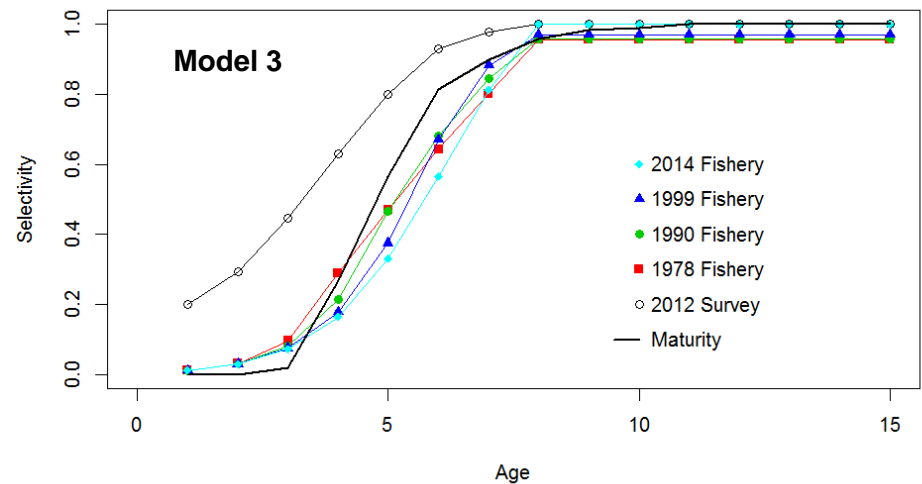
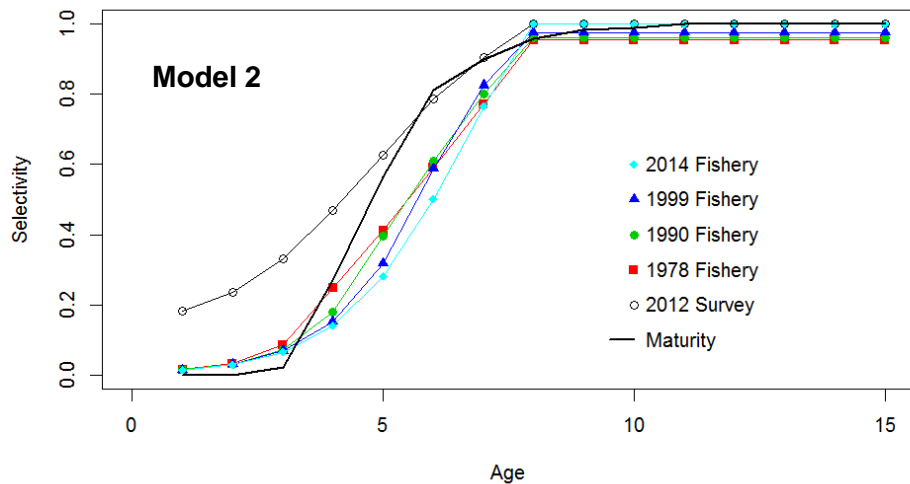
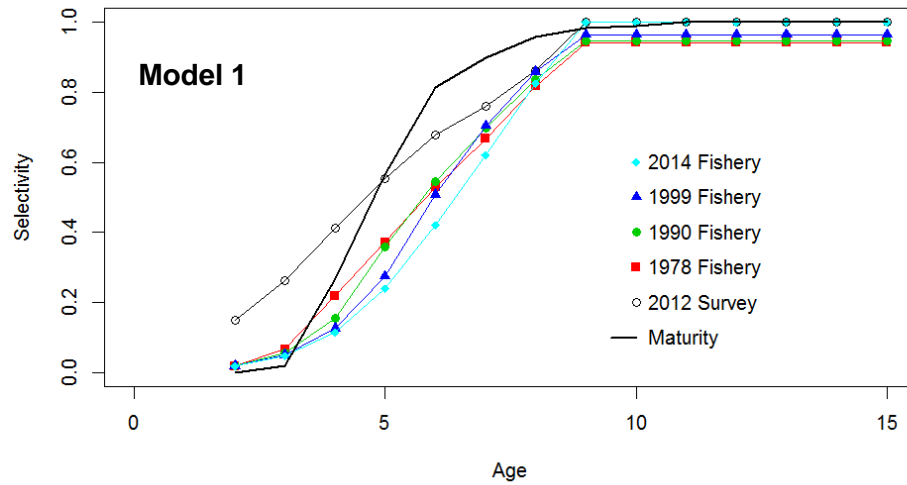


Fit to AI bottom trawl survey

- Similar fits to age composition data for all Models



Selectivity

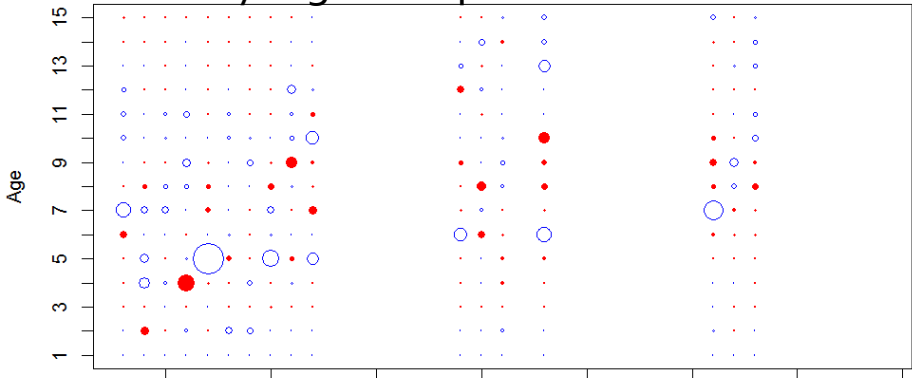




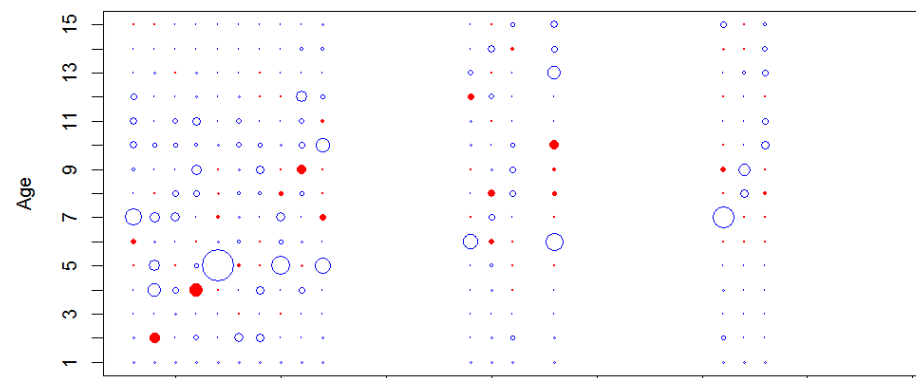
Age composition Residuals

Model 2

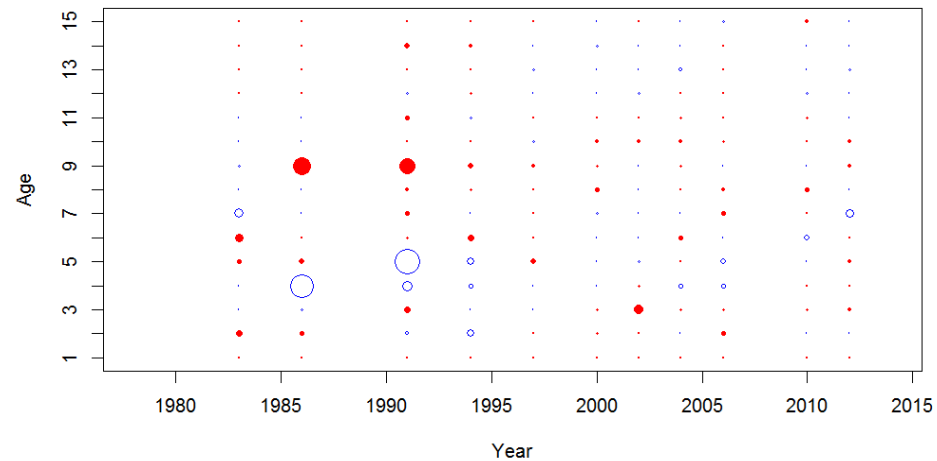
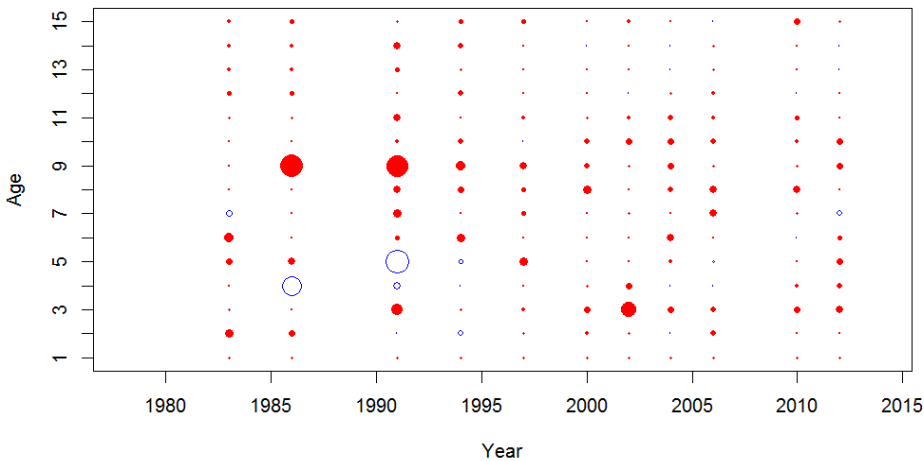
Fishery Age Composition Residuals



Model 3



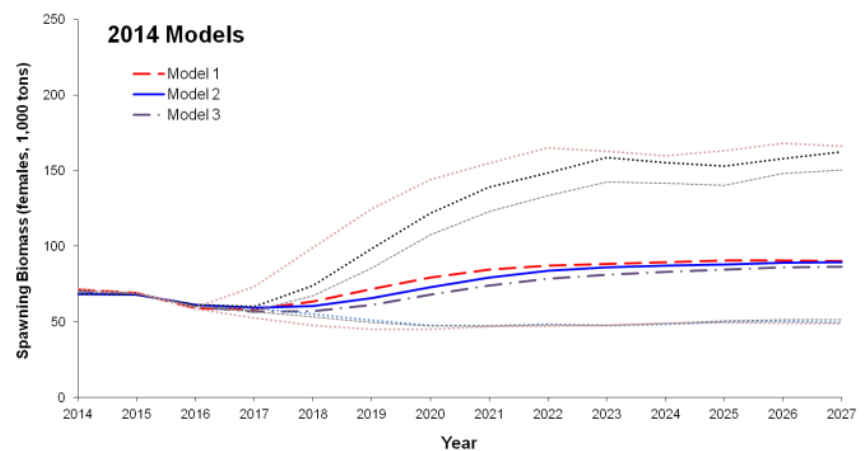
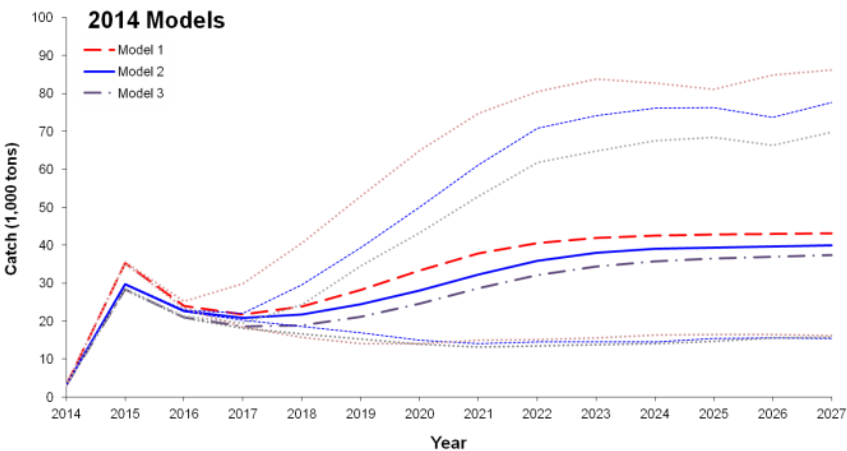
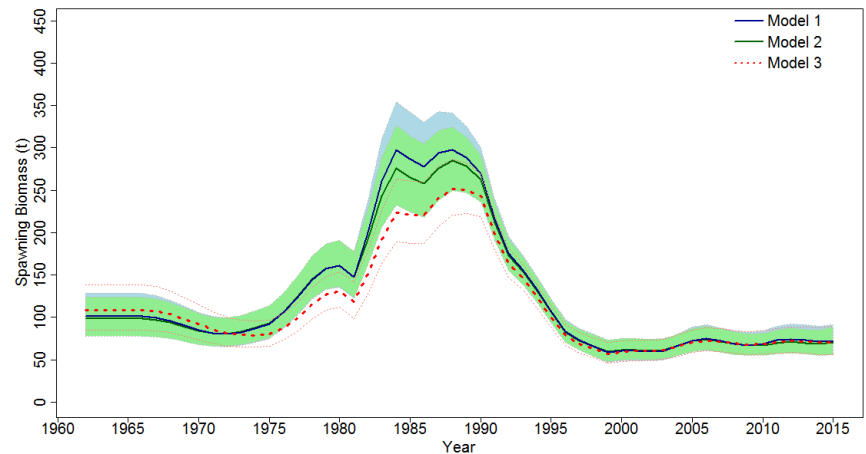
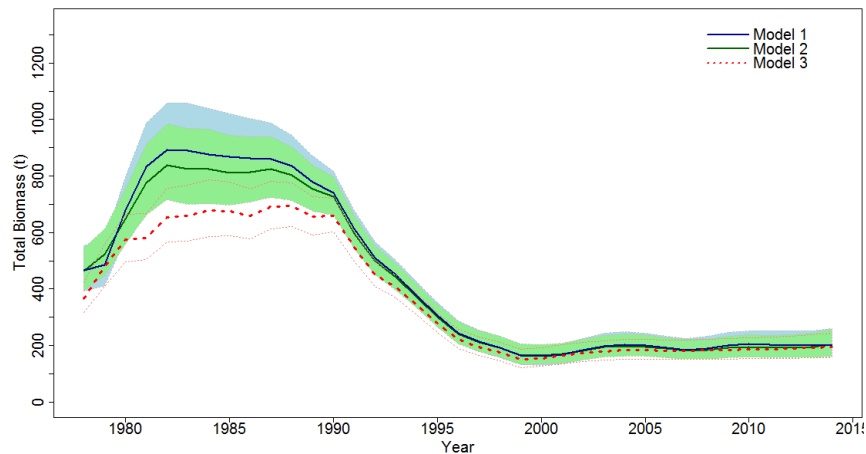
Survey Age Composition Residuals





Model comparisons

■ Results remain consistent



Model Comparisons

	Model 1	Model 2	Model 3
Number of Parameters	136	137	137
Survey Catchability	1.00	1.00	1.00
Fishery Average Effective N	49.80	47.21	45.80
Survey Average Effective N	84.14	78.85	95.01
RMSE Survey	0.55	0.55	0.56
RMSE Fish Ages (2-15)	0.041	0.042	0.042
RMSE Survey Ages (2-15)	0.041	0.039	0.037
-Log Likelihoods			
Survey Index	29.536	30.493	29.832
Fishery Age Comp	247.249	275.080	268.686
Survey Age Comp	59.624	67.836	53.696
Catch	0.881	0.937	0.882
<i>Sub Total</i>	337.290	374.346	353.096
-log Penalties			
Recruitment	51.864	52.210	49.393
Selectivity Constraints			
	Survey	1.810	1.858
	Fishery	15.562	16.697
Prior	0.005	0.065	2.978
Fpen	0.001	0.001	0.001
Residual	0.006	0.012	0.000
<i>Total</i>	411.219	444.006	424.023

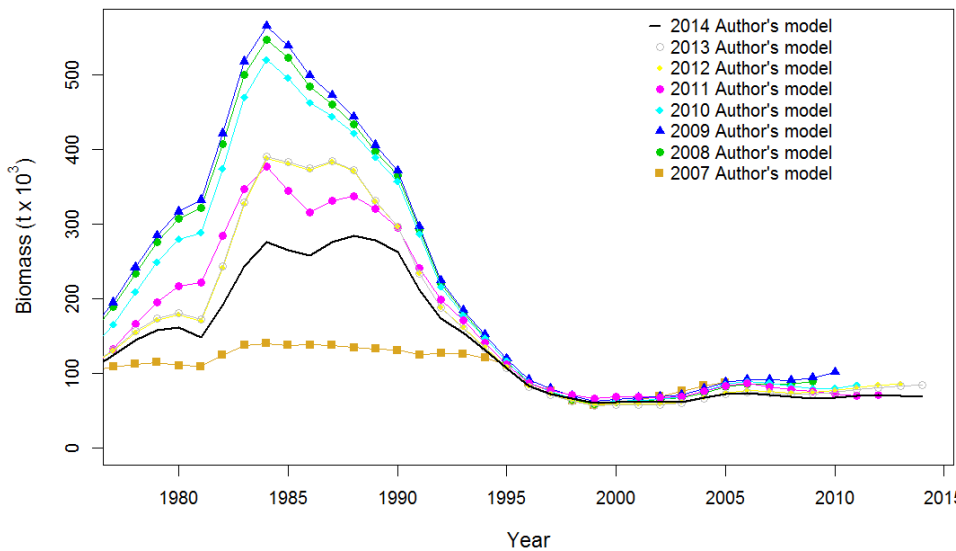
Results

Model 2

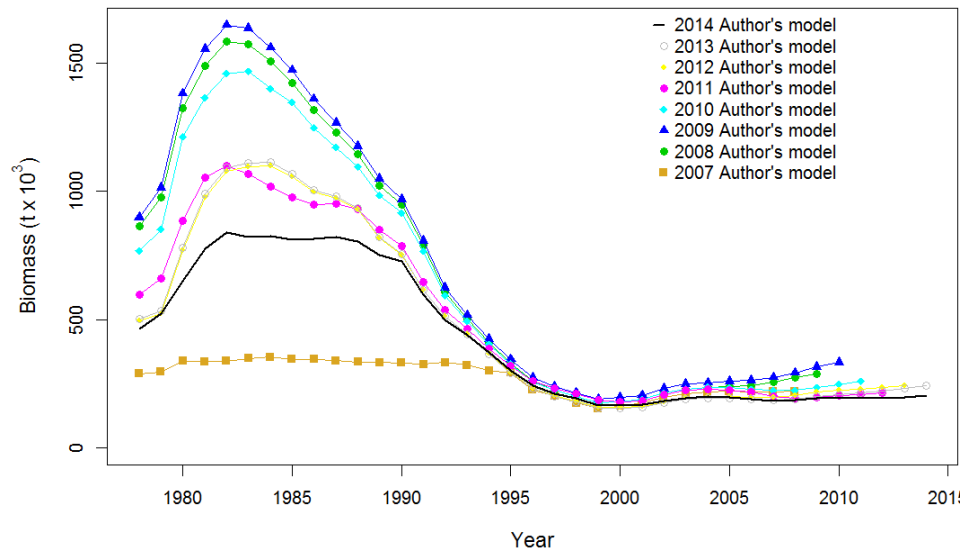


- Continued low survey biomass lowers estimates
 - Natural mortality (0.18)
 - Lower spawning and total biomass
 - $SSB_{2015} = 70,012\text{t}$ (down from last year's projection of 87,479 t)
 - $Total\ biomass_{2015} = 228,102\text{ t}$ (down from 289,307 t)

Female SSB



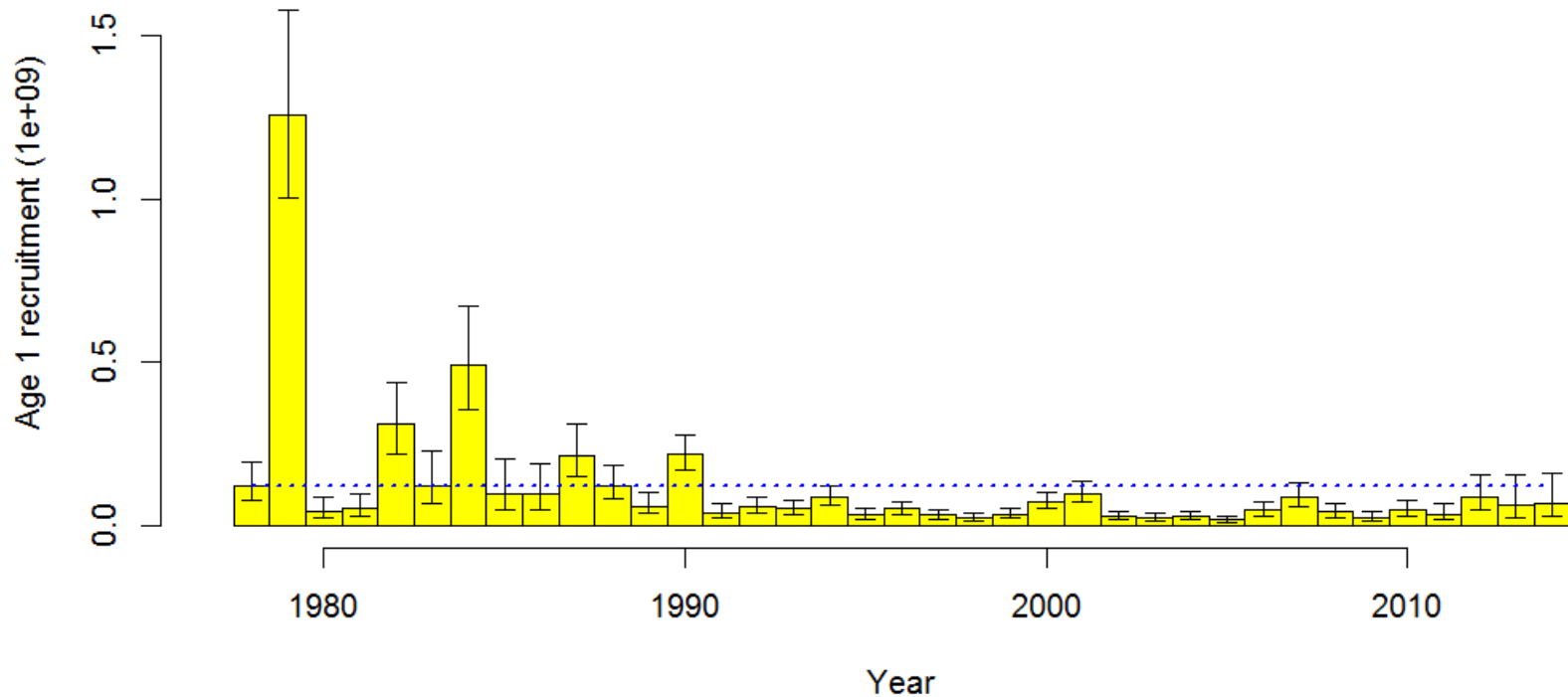
Total Biomass



AI pollock recruitment Model 2



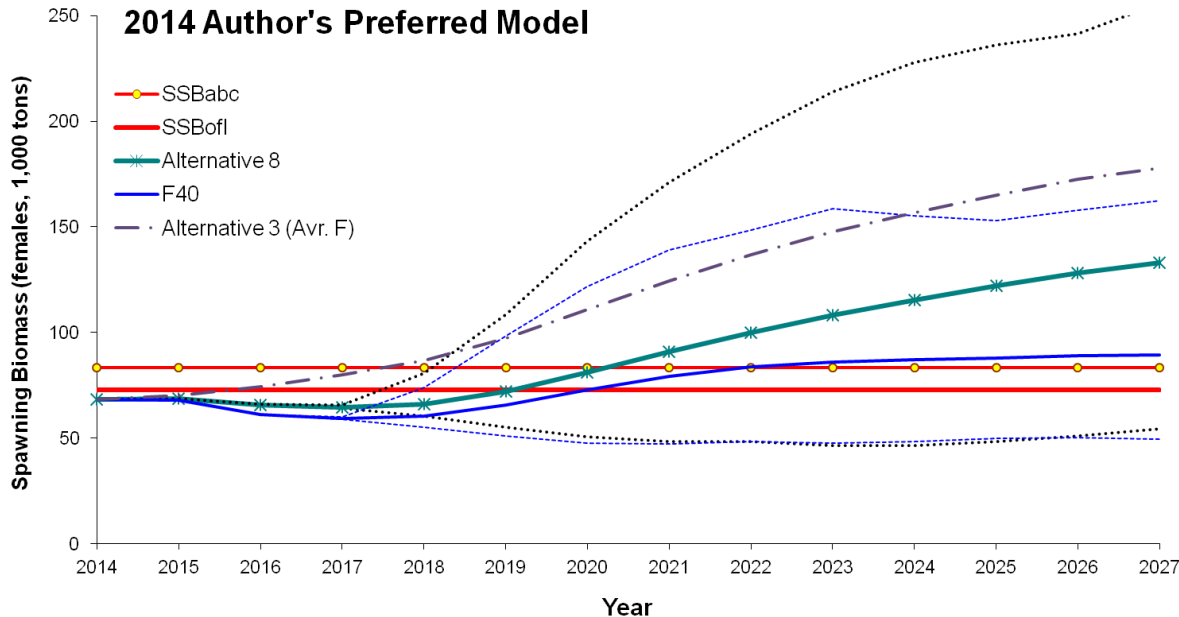
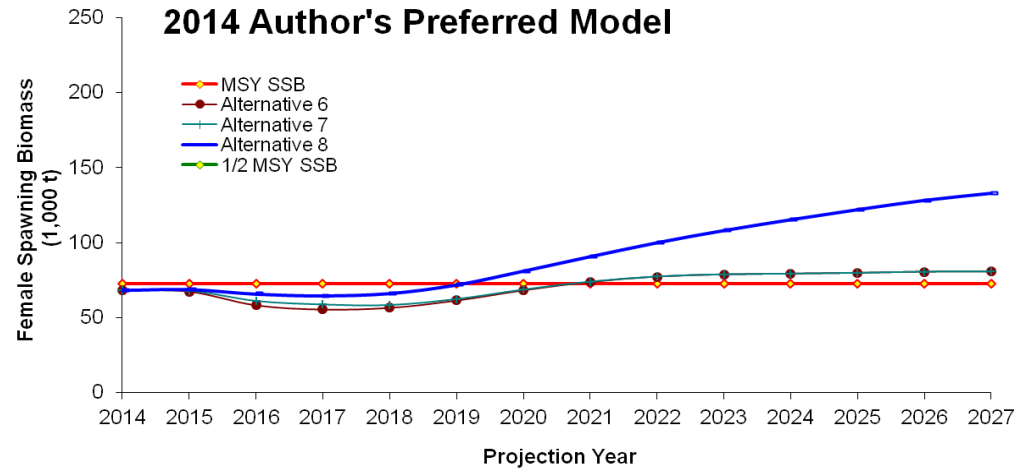
- Low recruitment since 1989
- “Better” recruitment in 2000, 2006, and 2011



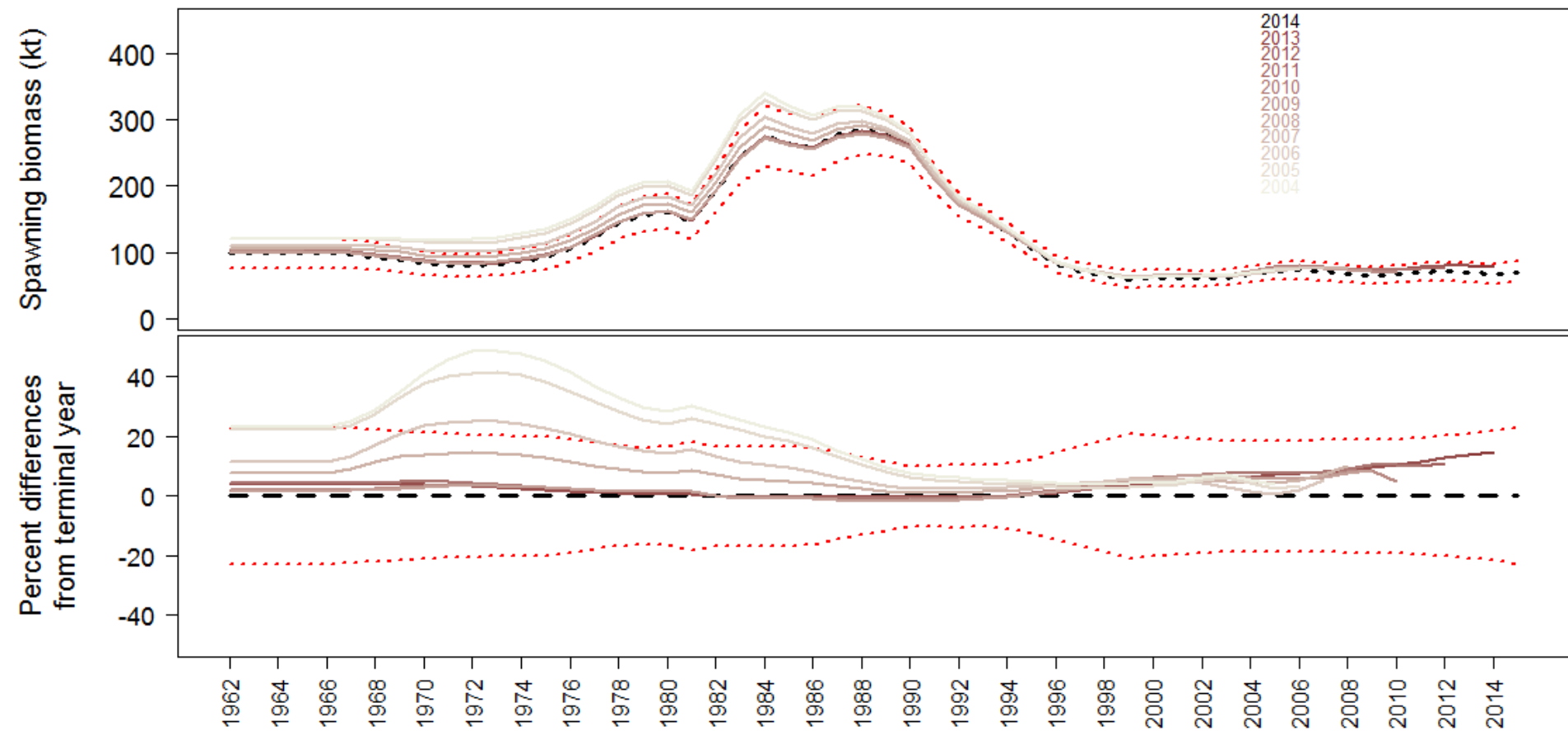
AI pollock status

Model 2

- Tier 3b
- Not overfished
- Not overfishing



AI pollock retrospective Model 2



AI pollock summary table

Model 2



Quantity	As estimated or <i>specified last year for:</i>		As estimated or <i>recommended this year for:</i>	
	2014	2015	2015	2016
M (natural mortality rate)	0.18		0.18	
Tier	3b		3b	
Projected total (age 2+ for previous and age 1+ for current) biomass (t)	259,525	289,307	228,102	249,523
Projected female spawning biomass (t)	81,711	87,479	70,012	71,772
$B_{100\%}$	240,016		207,606	
F_{OFL}	0.33	0.33	0.32	0.33
$maxF_{ABC}$	0.26	0.28	0.25	0.27
F_{ABC}	0.26	0.28	0.25	0.27
OFL (t)	42,811	47,713	36,005	38,699
maxABC (t)	35,048	39,412	29,659	31,900
ABC (t)	35,048	39,412	29,659	31,900
Status	As determined <i>this year for:</i>		As determined <i>this year for:</i>	
	2012	2013	2013	2014
Overfishing	no	n/a	no	n/a
Overfished	n/a	no	n/a	no
Approaching overfished	n/a	no	n/a	no